ELECTRICAL ENGINEERING

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The Cover: HMTS *Monarch*, world's largest cable-laying ship, which recently began paying out transatlantic telephone cable in Newfoundland waters as the first step in a system which will provide direct New York–London telephone circuits. Note bow sheaves over which cable passes during laying. (See "Of Current Interest," pages 741–2.)

AUGUST
1955

Planning for the Future ... A. C. Monteith 639
Education and Atomic Energy ... W. F. Libby 642
Air-Supply System for Compressed-Air Circuit Breakers ... J. E. Schrameck 646
Electronic Facilities Control ... J. J. De Matteis 650
National Survey of Scientific Research and Development ... A. T. Waterman 654
The Lamme Medal
Establishment of the Medal ... S. B. Crary 662
Career of the Medalist ... J. F. Fairman 662
Opportunity and Co-operation in the Electrical Industry ... A. M. deBellis 664
Color-Video Transmission Over Intercity Television Networks ... G. J. Harms 667
Stable Transistor Oscillator ... Edward Keonjian 672
Adjustable-Speed Drives and Their Use in the Paper Industry ... W. H. Buford, G. E. Shaad 676
The Roots of Automation ... D. C. Burnham 681
Nomenclature of Frequencies ... G. B. Ransom 683
Quadriphase—A New Approach to Time-Division Multiplexing ... W. E. Evans, R. F. Lowe 685
Measuring and Recording Atmospheric Electrostatic Potential ... J. S. Carroll, S. B. Hammond, E. H. Stewart 690

TECHNICAL PAPER DIGESTS
Improved Detached-Contact Circuit Drawing ... F. T. Meyer 645
An Automatic Field Plotter ... R. Gelfand, B. J. Shinn, F. B. Tuteur 660
Perpendicularly Superposed Magnetic Fields ... Robert Heartz, R. O. Buelteman, Jr. 661
Calculating Servo Transient Response ... D. V. Stallard 666
Applications of Statistics to Motor Testing ... J. L. Oldenkamp 671
Control-System Design for Minimum Bandwidth ... G. C. Newton, Jr. 689
Analysis of Optimum Shape for Magnetic Amplifiers ... B. D. Bedford, C. H. Willis, G. C. Dodson 694
Effect of Skew on Induction Motor Fields ... C. E. Linkous 695

Miscellaneous Short Items: New Antenna for *TPS-1D* Radar, 644; Hollow-Shaft Vertical Motors for Pumping, 649; "Stethoscope" at Work, 659; Lighting Generators for Biggest Commuter Cars, 670; Testing Tower for Landing Gear, 675; Flight-Opening Cargo Door, 688; *ERA-1130* Digital Computer to Solve Aircraft and Missile Problems, 693

Institute Activities 696
AIEE Fellows Elected, 705; AIEE Personalities, 705; Obituaries, 707; Membership, 708

Report of the Board of Directors 709

Of Current Interest 741
New Books, 748; Pamphlets, 751

Industrial Notes 21A
New Products, 30A; Trade Literature, 46A

Index to Advertisers 76A

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M. D. HOOVEN, President
N. S. HIBSHMAN, Secretary
PUBLICATION COMMITTEE: W. Scott Hill, *Chairman* J. D. Tebo, *Vice-Chairman* E. W. Boehne J. G. Brainerd
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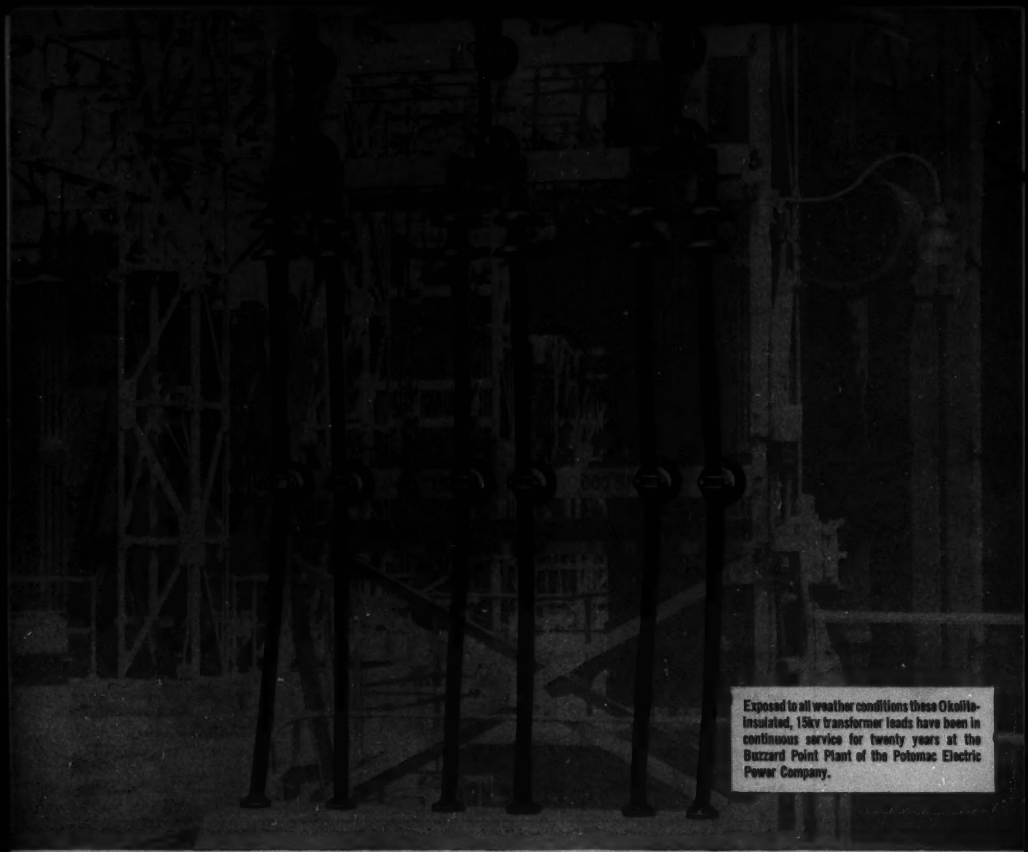

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HIGHLIGHTS.....

Board of Directors' Report. The 71st annual report of the AIEE Board of Directors for the year 1954–55 is included in full in this issue. It contains brief summaries of the activities of the Institute and its committees during the year, and also includes the accountants' statements showing the financial condition of the AIEE at the close of the fiscal year (*pp. 709–40*).

Planning for the Future. In his address before the AIEE Summer General Meeting, A. C. Monteith, outgoing president of the Institute, points out that we must do our planning for the future now if we are to maintain and improve our position of leadership. The first step is a survey to determine what the members want; the second step is to determine how these objectives can be realized (*pp. 639–41*).

Research and Development Survey. The director of the National Science Foundation discusses a series of studies which the Foundation is making concerning the status of research and development in the United States. Although the survey is not yet complete, such data as have been gathered to date are presented (*pp. 654–9*).

1954 Lamme Medalist. AIEE's Lamme Medal for 1954 was presented during the recent Summer General Meeting to Aldo M. deBellis of Consolidated Edison. A brief history of the medal, a résumé of the medalist's career, and the acceptance address by Mr. deBellis are included in this issue (*pp. 662–5*).

Education and Atomic Energy. The shortage of well-trained scientists and engineers is discussed and its danger to the national security pointed out. The vital responsibility of colleges and universities in alleviating the situation is indicated in connection with the dedication of the first institutional research and teaching reactor (*pp. 642–4*).

Air-Supply System for Compressed-Air Circuit Breakers. This system provides flexible use of piping, pressures, and compressor, together with storage capacities through sectionalizing valves located to isolate different sections of the system (*pp. 646–9*).

Electronic Control of Facilities. This innovation uses carrier current signals and operates entirely over existing electric circuits. It can, therefore, automatically switch on or off a maximum of 40 groups of remote operations—each on its own schedule. All this is achieved without the installation of a single transmission wire (*pp. 650–4*).

Stable Transistor Oscillator. These oscillators operate in the 1–2-mc range, obtaining a stability of 10 to 20 parts per million for ±10-per-cent changes in supply voltage as compared with 200 to 400 parts per million for the unstabilized oscillator. A temperature stability of 1 part per million per degree C was obtained as compared with 50 parts per million per degree C for the unstabilized oscillator (*pp. 672–5*).

Measuring and Recording Atmospheric Electrostatic Potential. The electrostatic voltmeter described consists of a radioactive probe which measures the atmospheric electrostatic potential, a rotating capacitor which converts the d-c signal from the probe to an a-c signal, an amplifier to amplify this signal, and a recording meter (*pp. 690–3*).

Nomenclature of Frequencies. The development of the present standard, the need for broader standards, recommendation of the technical societies, and the international action are discussed. The proposed system, which may be adopted officially, offers flexibility as it can be extended further (*pp. 683–5*).

Adjustable-Speed Drives and Their Use in the Paper Industry. These drives have contributed tremendously to the increased efficiency during the last 10 years in the paper industry. Mill experience has indicated that the flexibility of the adjustable-voltage d-c drive or the simplicity of the wound-rotor drive fit the requirements of most drives (*pp. 676–81*).

The Roots of Automation. Its development is traced so that automation is clearly shown to be the next logical evolutionary step in manufacturing history. It also emerges as an economic necessity to continue accelerating the rate of progress (*pp. 681–3*).

Color-Video Transmission Over Intercity Television Networks. With the transmission of color-video signals, the problems encountered in monochrome transmission still exist, and many other difficulties are added because of the nature of color signals. Attempt is made to improve transmission so it is free of any distortion (*pp. 667–70*).

Quadiphrase—A New Approach to Time-Division Multiplexing. This newly designed system gives a completely new approach to the synchronization problem formerly encountered in the time-division multiplexing systems, which had required top-quality components, regulated power supplies, and good design and maintenance to achieve the desired performance (*pp. 685–8*).

News Index

Institute Activities 696

Pacific General Meeting 696
Petroleum Industry Conference 699
Future AIEE Meetings 699
Summer General Meeting 700
Fall General Meeting 701
Conference Papers Open for Discussion 704
AIEE Fellows Elected 705
AIEE Personalities 705
Obituaries 707
Membership 708

Of Current Interest 741

Transatlantic Telephone Cable 741
Commercial TV in Britain 742
Future Meetings of Other Societies 743
New Books 748
Pamphlets 751

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

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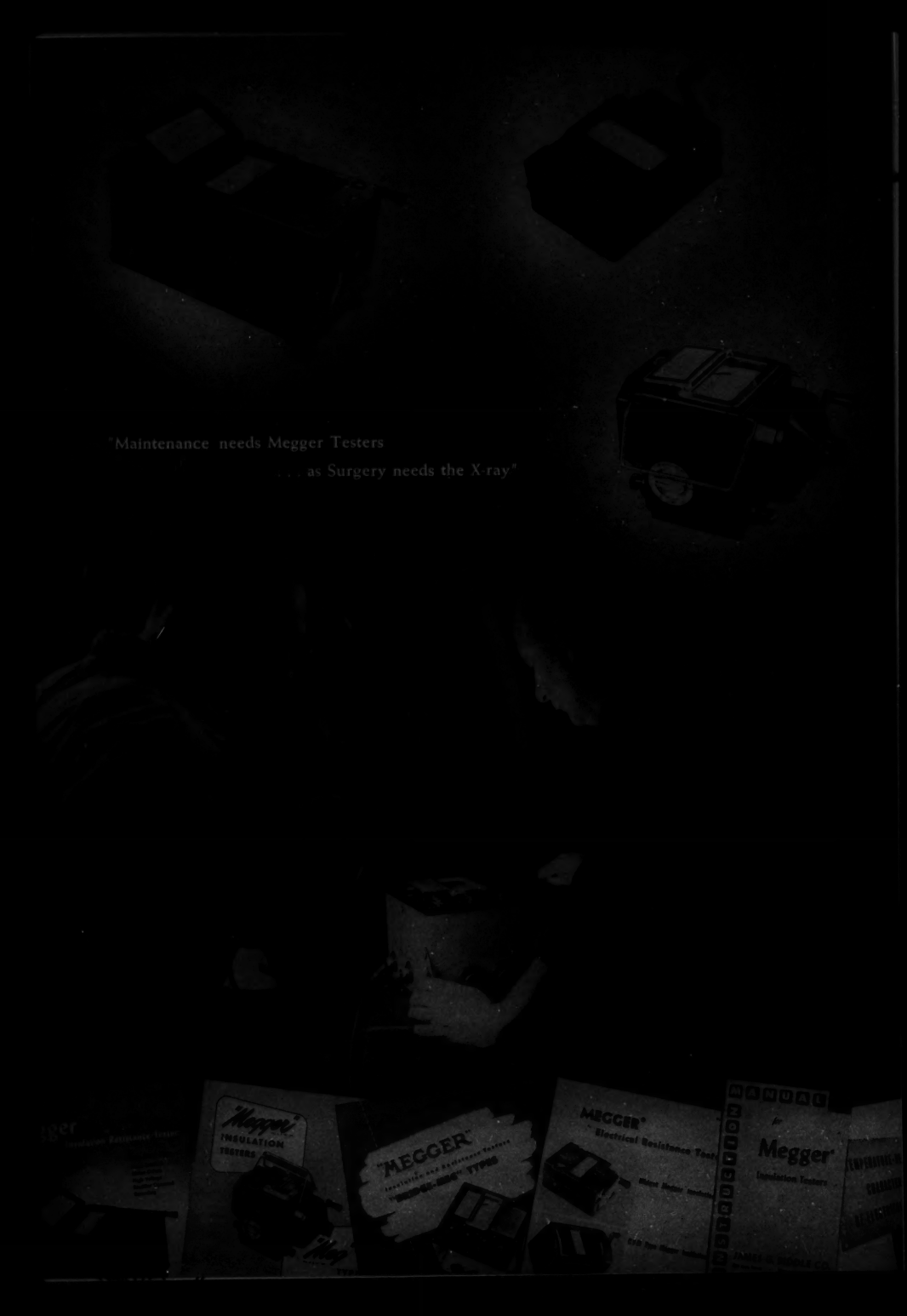
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Vol. 7
195

Planning for the Future

A. C. MONTEITH
FELLOW AIEE

At the end of his term as president of the AIEE Mr. Monteith reports on the current status of the Institute, what has been done during the past administrative year, and plans for the future.

THE OVER-ALL THEME of the year's program for the Institute has been "Planning for the Future." How well we have met this encompassing challenge will be told in the course of this meeting. But be that as it may, make no mistake, this Institute has a bright and promising future.

Whether we realize this potential depends on how well we serve our membership, who in turn serve the electrical industry. The electrical industry, itself, as one of the fastest growing industries in our economy, is a good indicator of the potential of this Institute.

The increasing significance of the electrical industry is revealed by its increasing share of the nation's gross product. From less than 2 per cent of the gross national product in 1925, the electrical industry advanced to 4 per cent in 1950 and by 1965 it will have risen to 6 per cent. If this percentage is integrated with the over-all increase of goods and services, we can confidently expect that the electrical industry will double in the next 10 years. Furthermore, a parallel increase in complexity of operations can be expected to require doubling the number of engineers employed by the industry.

An address presented at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955.

A. C. Monteith, AIEE past president (1954–55), is vice-president, Westinghouse Electric Corporation, Pittsburgh, Pa.

Today, AIEE with 49,000 members is operating basically the way it did 30 years ago when it had 18,000 members. But with a potential of 100,000 members, it is obvious that we must do our planning for the future now if we are to maintain and improve our position of leadership. That planning was our primary concern this year.

As a first step in preparing for this future, we inaugurated a fact-finding survey to determine what our members wanted. The method used was personal interview of a scientific sampling of AIEE members. The advantages of this method were the clearness and completeness of the answers. Furthermore, we even found out the ideas and opinions of the members who never return questionnaires. Results from this study are now being reviewed but definite conclusions have not yet been drawn.

After the members tell us what they want, the second step will be for a group of outside consultants to tell us how these objectives can be realized. This consultant group specializes in organization, and currently they are studying Institute operations. The consultants expect to have their basic work done within the next few months, and their final recommendations are expected to be ready for your consideration this fall. This cold, hard, impersonal look at our Institute by outside experts should prove to be the most valuable program we have undertaken this year to strengthen our Institute for its promising future.

But, while looking ahead, we worked for the present, too. I am pleased to report that substantial progress was made during the past year, both on matters within our organization and on several co-operative ventures. The trend of

A. C. Monteith (left) presents the President's badge to his successor, M. D. Hooven

the past few years of increased activity across-the-board has continued. Most programs again set new highs—there were more members, more sessions, more papers, and more committees.

GENERAL AND TECHNICAL ACTIVITIES

DURING THE YEAR the Institute has been strengthened by many constructive improvements in general and technical activities. Some of the more significant of these achievements will be reviewed here.

A constructive, new policy that we believe will help future expansion is the Board's decision to permit large Districts to divide themselves. As you know, there has been a general feeling that something should be done to lighten the load of the officers of the big Districts. At the same time, there was no agreement on redistricting the Institute as a whole. The Board's self-determination policy provides quick relief for Districts sorely pressed, and offers flexibility in progressing toward a possible 14-District pattern for the Institute. District 2 has voted to exercise this local option by creating a District 2 (Middle Eastern); and a new District 11 (East Central), effective August 1.

We believe we have made some headway this year toward solving another long-range problem—public relations. In the past, the Committee on Public Relations was handicapped by lack of a clear-cut policy directive from the successive Boards. We agreed the Board should direct this important function, in accord with a carefully considered and continuing policy. To set this policy, a special committee has analyzed the Institute's public relations activities and made six recommendations, which the Board accepted. Now, a new committee is working out plans for realizing these objectives. With this information in hand, we should be able to formulate and implement a policy that everyone will understand.

Finally, we raised the dues $5, which I know does not come as news to you. However, I did want you to know how much I appreciate your reaction to a necessary, though unpleasant, action. The dues increase has been well accepted by our members. Last year by the end of June we had received a total of 238 resignations. This year, up to the end of June, we have received 500 letters or notices of resignations. Less than 100 referred to the increase of dues as the cause for resignation. I want to express my appreciation, and the gratitude of the Board, for your courteous and prompt endorsement of this policy. To be perfectly fair, I must tell you that a relatively few members objected to the increase clearly and loudly, but thus far resignations are negligible. We will not have the real answer, however, until the end of the year.

Almost every other activity within the Institute—such as publications, Sections, Examiners, awards—has shown major progress. For example, special attention has been given to the diversified problems of engineering students, by providing for additional Affiliate Branches.

In addition to the general activities there were a number of prominent technical advances.

First, to make conference papers more generally available to members who cannot attend meetings, all conference papers received 60 days before the meetings are preprinted. Suitable preprinted conference papers can be converted into *Transactions* papers now, without "re-presentation for discussion."

Second, an intensified effort is underway to help authors, speakers, and committee members understand the technical operations of the Institute. For example, the "Author's Guide" and "Technical Sessions Guide" are being brought up to date. In addition, a forum of technical committee chairmen is being held at all General meetings instead of just at the Winter General Meeting.

Third, for over-all increased efficiency of technical operations, special task forces are busy working out the best solutions to such problems as:

1. The best way for several divisions to work together on broad technical subjects of mutual concern.
2. The proper allocations of papers for review and publication, when the subject matter falls within the scope of two or more technical committees.
3. What to do about overlapping interest in our present technical committee structure.
4. An initial exploration of how to create among all Institute members more of a feeling of "belonging" to one or more of the technical activities of interest to them.

Finally, special technical conferences are being stressed to meet the needs of those working in highly specialized fields.

In general, the technical committees are doing an excellent over-all job. However, the recommendation discussed at the technical forum at the Fall General Meeting—that officers of technical committees emphasize "advance planning" and "management" factors—points a path toward greater operating efficiency.

PROFESSIONAL UNITY

FINALLY, what have we done about two external problems? These are the questions of professional unity and the status of the new Engineering Center Building.

The problem of professional unity is complex. There are many ideas on how this goal should be achieved, and over a period of years some ideas have solidified to the point where compromise is difficult. Despite setbacks, progress is being made; at least, sincere people are discussing the differing points of view in good faith. Under such conditions, an acceptable plan can be expected to be hammered out.

The Board is still working toward the two goals outlined by the membership several years ago; these were (1) to co-ordinate the thinking and efforts of all technical societies in broad, technical matters, and (2) to represent the entire engineering profession on broad nontechnical matters.

AIEE representatives are working for a modification of Engineers Joint Council, to convert it from a federation of societies to an over-all organization of individual members. A suggestion for an over-all plan includes two autonomous branches; one technical, one professional. Each branch would be represented on a co-ordinating Board of Directors, which might be designated as "The American Engineering Association." Membership would be common to the two branches, and each branch would be made up of

individual members who would vote on activities and financing.

On the second outside activity, the new Engineering Center, the Founder Societies are slowly coming to a decision on the location of the new Engineering Center Building.

To review the problem for the newer members, a half-century ago Andrew Carnegie provided funds to the Founder Societies for the Engineering Societies Building in New York, N. Y. The land was purchased by the societies. When the societies outgrew this facility several years ago, a study was initiated for acquiring a new headquarters building.

Preliminary work on the project was accomplished by United Engineering Trustees, Inc., a group made up of three representatives of each of the Founder Societies. This group acts as the holding company for the societies. During the past year, several cities knowing of the need voluntarily offered gifts of land and money to the new engineering headquarters. To help get a decision, about a year ago a committee of presidents of five societies (American Society of Civil Engineers, The American Society of Mechanical Engineers, AIEE, American Institute of Mining and Metallurgical Engineers, and American Institute of Chemical Engineers) was formed, with Elgin Robertson as chairman. This committee analyzed the proposed locations in New York, N. Y., Philadelphia and Pittsburgh, Pa., and Chicago, Ill. On February 2, 1955, this committee reported to each Board of the five societies that:

"Based on the lowest capital cost and lowest annual expenditure, we recommend that the headquarters of the engineering societies be located on one of the sites in the city of Pittsburgh."

To permit careful consideration, your Board postponed action on the five presidents' report until April. Joining with our sister societies, we asked for a more definitive report including all of the factors considered in making the recommendation.

The Committee of Five Presidents made this report to your Board on April 13, 1955, in St. Petersburg, Fla. The majority report was signed by four members. It included an analysis of the available data, and based on that analysis unqualifiedly recommended the Schenley Park site in Pittsburgh. A minority report signed by one member was also considered.

Your Board wrote the following letter to the governing boards of our sister societies:

"On February 3, 1955, the Board of Directors of AIEE authorized its Executive Committee to set the time and place for a special Board meeting, at which meeting the Board would consider the February 2, 1955, report of the Committee of Five Presidents.

"Subsequently, the Executive Committee set this meeting for April 13, 1955, in St. Petersburg, Fla., and requested 'The Committee of Five Presidents in the light of the apparent wishes of the majority of the Boards of the Five Societies to expand its letter of February 2, 1955, into a definitive and unqualified report outlining the facts which were taken into consideration in arriving at its recommendation of that date.'

"At this meeting on April 13, the Committee of Five Presidents presented a majority report, signed by four members, and a minority report from one member dated April 4, 1955, and based upon data available prior to February 1, 1955, which date had been agreed upon by the committee as the closing date for receiving final complete and definitive proposal or any proposals supplementary to those already submitted.

"This report included an analysis of the available data, and based on that analysis made an unqualified recommendation for the Schenley Park site in Pittsburgh, Pa.

"The Board of Directors of AIEE voted to accept and approve the majority report of the Five Presidents dated April 4, 1955, as presented, and recommends similar action to the other four societies."

Subsequent to the meeting of your Board, the American Institute of Chemical Engineers, at their meeting in Houston, Tex., on May 22, voted resolutions which, in essence, said that they were favorably disposed to the recommendation of locating an Engineering Center at the Schenley Park site in Pittsburgh; they appointed a man to negotiate, but in taking these actions, although Council indicated its definite interest in the proposed Schenley Park site they were not prepared to commit themselves at this time because they had certain financial problems to work out with respect to being able to become a full partner with the Founder Societies.

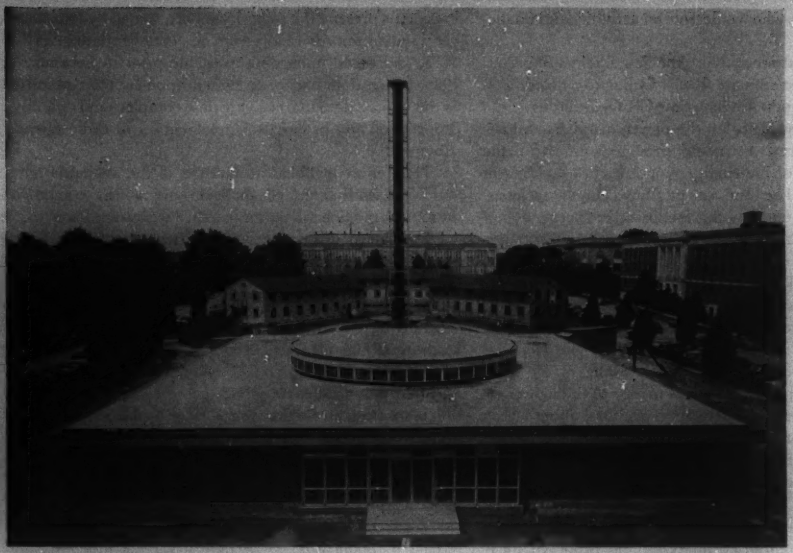
In the last two weeks, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, and The American Society of Mechanical Engineers have all met, and in essence voted to hold in abeyance any action on the Pittsburgh offer. They are asking for a task force to be formed for a further study. In analyzing the actions of these various Boards, it is not clear yet how a task force can be constituted and satisfy all of the actions taken.

You can therefore see that the matter of a definite selection of a location for the new Engineering Center is very confused and there is therefore no definite action to report to our members at this time other than the actions cited.

IN CONCLUSION

As I WORKED with the members throughout the year, I have been tremendously impressed by your unselfishness, your willingness to work as a team, and your sound engineering approach in our forward-looking planning for the future. These personal attitudes have made our Institute great—and they will make it greater. As the largest Founder Society, we have an obligation to provide more leadership in the future to guide group action of our country's technical organizations. If we have the will, I am confident we have talent to extend statesmanlike leadership in the public interest.

In closing, I want to thank each of you members, my coworkers on the Board, and the Headquarters staff, for your warm and helpful co-operation. It has been a high privilege to serve as President, and I am grateful for this rare and enriching experience. To Morris Hooven, our esteemed President-elect and long-time friend, I know you wish me to extend your very best wishes and personal support along with my own, for the year ahead.



Burlington Nuclear Laboratories, North Carolina State College

EDUCATION AND ATOMIC ENERGY

by W. F. LIBBY

The importance of the first research and teaching reactor to be built on a university campus is emphasized against the background of the United States' shortage of adequately trained scientists and engineers. How colleges and universities can help is pointed out.

THE NORTH CAROLINA STATE COLLEGE and all of its friends who have co-operated with it in making the reactor possible have done the country a great service in building this first institutional research and teaching reactor. It is pleasant to know that others are following your lead and that we can foresee a number of university reactors functioning for research and instructional purposes. (See title picture and Fig. 1.)

The activities you inaugurate in launching this pile will, I am sure, multiply and proliferate throughout the years and this day will be an historic one for your institution and for the whole country. (See Fig. 2.) It is a valuable teaching tool for the essential education of students in the new field of nuclear science and engineering. It puts emphasis again on the traditional nonfederally supported means for instruction.

In being financed by private sources, it ends a U.S. Government monopoly in a very important field. In being located on a university campus, it trains men and women under undergraduate circumstances so they can be exposed to the basic precepts of atomic science and industry in their earliest and most receptive years. It also will be a valuable tool in the adult education of graduate engineers who wish to become interested in nuclear science and industry. The entire activity will be strong support for the activities of the Oak Ridge Institute of Nuclear Studies and the Oak Ridge School of Reactor Technology.

In addition to its usefulness as a teaching instrument, it will produce isotopes and serve as a research apparatus essential to many valuable fields of investigation. We understand well that despite the high quality of the personnel in our national laboratories, the universities and colleges are unrivaled sources of new talent, and the catalytic effect of an atomic reactor in introducing new blood into the vital field of atomic energy can hardly be overesti-

Essentially full text of an address presented at the dedication of the first university research reactor, North Carolina State College of Agriculture and Engineering of the University of North Carolina, Raleigh, May 23, 1955.

Dr. W. F. Libby is with the U. S. Atomic Energy Commission, Washington, D. C.

mated. Our compliments to Dr. Beck* and his collaborators for designing the reactor and seeing to its construction. Their service has been a great one.

The shortage of adequately trained scientists and engineers is a matter of serious concern to the nation. We have to try to understand how it has come about and how serious it is. It seems clear that among the causes are inadequate salaries for high school teachers, and consequent inadequacy in the offerings of the high school curricula. In addition, one realizes that the colleges and universities have sometimes done an inadequate job of instruction. The type of people who can successfully pursue a career in scientific and engineering fields have many doors open to them, and the competition in the freshmen and sophomore years in the colleges and universities for their interest is acute. We can understand, therefore, in part that uninspired teaching may have contributed to our present difficulties. Certainly you who are on this campus will be able to present an important part of modern science and engineering in a most impressive manner. This use of your reactor may be one of the most important from the national point of view.

There are other probable causes contributing to the shortage. The scientific fields themselves have a tendency to change rapidly in the sense of their newness. It is characteristic of the research man that he is interested in the newest fields and it is also true that the research man is frequently the most interesting teacher in the scientific field. This remark, of course, does not apply directly to engineering instruction, but it is still true that many engineers first become interested in the sciences themselves. It is to be hoped that the continual discovery of new applications and new aspects of the sciences and engineering will keep them in a condition of freshness which will prove to be sufficiently attractive. This recasting and redescription is in itself an important task of the good teacher.

The shortage is endangering the national security in a vital sense because our industrial strength is dependent on the scientific and engineering fields. Our supremacy in advanced military technology is threatened and the shortages are actually greatest in those specialties most important to national defense. Furthermore, the change tends to be self-perpetuating and the secondary schools cannot obtain qualified science and mathematics teachers for even the present requirements, let alone for the foreseeable growth in the future. About 80 per cent of our high school graduates do not receive bachelor degrees, and only about 2 per cent of those judged mentally capable of obtaining doctoral degrees in any field, do so. Our concern for science and engineering does not in any way reflect upon the essentiality of other professions or occupations. It is, however, the field of science and engineering in which we are confronted with a shortage that must most immediately concern us.

We must improve the teaching of science and mathematics in the high schools by providing more qualified teachers, better teaching aids, and consolidating schools to permit more courses, etc. At the high school level we must improve the identification, motivation, and guidance of qualified students towards careers in science and engineering. Also, we must increase the number of qualified students who go to college, and encourage those with scientific and engineering aptitudes to pursue the courses in science and engineering. We must develop the necessary incentives to retain highly qualified scientists and engineers in colleges and universities. Finally, in addition, we should consider the improved utilization of scientists and engineers by providing additional technical personnel to relieve them of subprofessional assignments.

It appears that the responsibility for these necessary

* Chairman, Physics Department, North Carolina State College of Agriculture and Engineering.

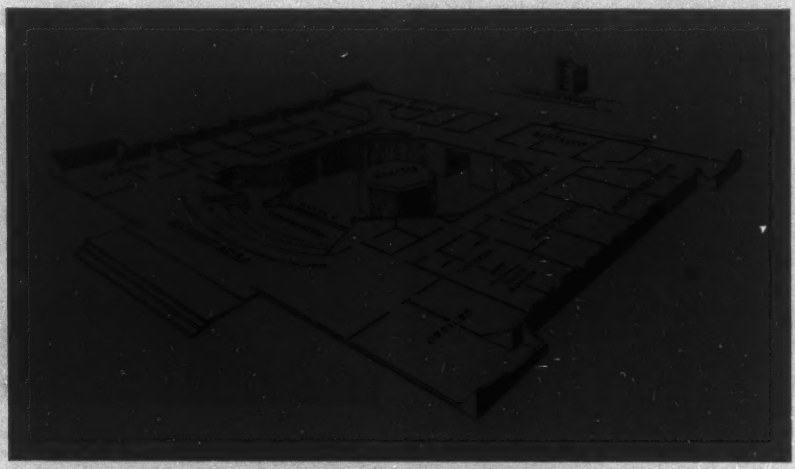


Fig. 1. Floor plan of the Burlington Nuclear Laboratories

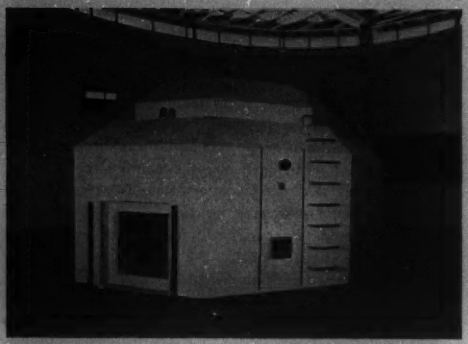


Fig. 2. Research reactor shielding assembly inside the Burlington Nuclear Laboratories

changes rests primarily with the leaders in the universities, colleges, and high schools in the general fields of education, as well as with the scientific and engineering professions in industry and labor. The acuteness of the problem is widely recognized, but it is not clear that the methods of solving it are generally accepted. It is very difficult to believe that so small a group of people can be so vitally important. Of course, we have learned this lesson with physicians, although I understand there are shortages in some parts of this field also.

The awful aspects of atomic and thermonuclear bombs have overshadowed in peoples' minds the beneficent aspects of the atomic age. As has been widely stated, we try in the Government to develop the peaceful uses of atomic energy at the maximum rate and to the maximum extent possible. One of the broad fields of peacful application is that of isotopes and radiation. The use of tracer in research and industry has just begun. Industry last year benefited by over $100 million in savings by the use of radioactive materials in various ways. Despite this, no industries are making significant use of the extremely important isotopes of carbon and hydrogen, despite the fact that the chemistry of these two elements is of such tremendous importance.

This will change with time and it is clear that isotopes will become an even greater blessing to the American people and to the world as a whole. Your reactor may well serve in the development of some of these new uses. Let us hope that it will lead, because of its location on an active campus, to the generation of a host of new applications and an increase in our understanding of the principles underlying them. The use of isotopes only awaits discovery of new applications. They are available in enormous quantities and the supply can be increased on very short notice. Recently the Government has undertaken a broad subsidy to the extent of 80 per cent for all medical and biological uses. Certainly isotopes and the varied uses of radiation itself in the sterilization of foods, the generation of new species by mutation, industrial roentgenology, etc., may well rival the second greatest peacetime application of the atom—atomic power. It is to be hoped that you will continually remind the students that there is a rich harvest in this field of application.

Atomic power, we all realize, is yet to be obtained in economic form and many of us believe that this day is not too far removed. The gratifying response that the Atomic Energy Commission received to its invitation for proposals in its Power Demonstration Reactor Program is extremely pleasant and tangible evidence that the feeling and conviction is widespread. In this instance, the military applications may be helpful to the peaceful uses just as they have been in similar cases in the past.

However, there are several sizable hurdles remaining before we can achieve economic atomic power. One of the largest of these is education in the new field—education of not only the technical engineering and scientific personnel, but also of the general public. The importance of giving the general public a general knowledge of nuclear phenomena can hardly be overestimated. Important aspects of national policy thus affected are civilian defense against atomic attack and the potential peaceful and beneficent uses of the atom. All of us must help in this task but the main load must necessarily be carried by the educational institutions like your own. It is one of the most important teaching assignments American education ever has had. We must interest people and teach them to understand this new world. They must learn of the scope and nature of the basic or natural laws underlying it in order that their good common sense can be brought to bear on our national problems. To you who have pioneered in bringing reactors and all they mean to the college campus, it is a pleasure to say this since it is certain you will agree and have indeed begun on a course which will well serve these ends.

New Antenna for TPS-1D Radar

A 40-foot antenna, developed for the U. S. Signal Corps by Raytheon Manufacturing Company for widely used *TPS-1D* surveillance radar, weighs 7,500 pounds with its motorized pedestal and is important in aircraft detection.

Improved Detached-Contact Circuit Drawing

F. T. MEYER
MEMBER AIEE

THE ever-increasing complexity of telephone and telegraph switching circuitry in the Bell System had reached a stage about 10 years ago, where many of the conventional type of schematic circuit drawings presented difficulties in training of personnel and maintenance. It then became necessary, particularly for the more complex circuits, to prepare and maintain a separate series of drawings—especially streamlined for training purposes and for aiding maintenance. However, the preparation of two sets of drawings for these cases and keeping them in step as improvements and changes were added was costly.

To meet this problem the Bell Telephone Laboratories developed an improved detached-contact type of schematic circuit drawing designed for easy understanding and incorporating in a single package the basic circuit information required for manufacture, installation, training, maintenance, and engineering analysis.

The principal differences between the old conventional and the new detached-contact types of drawings may be summed up as follows: In the older drawing apparatus components such as relays are symbolized in their entirety and shown as an integral part of the circuit pattern. The arrangement and content of each figure is based on a predetermined physical association of apparatus. Stressing of circuit paths is not feasible; the same path frequently appears on a number of sheets. This often results in a mixture of many paths on the same sheet making the more complex drawings extremely difficult to understand.

The new type of drawing is laid out in patterns of straightforward functional circuit paths readily seen at a glance and easily understood. Fig. 1 illustrates such a path. The contacts and actuating mechanisms of components such as relays are detached from each other and placed in proper sequence along those functional paths of which they are a part. To show such paths by straight lines, new symbols are used for contacts. A "make" contact, open when not actuated, is represented by an *X*. A "break" contact, closed when not actuated, is represented by a —. A "transfer" contact uses a combination of both.

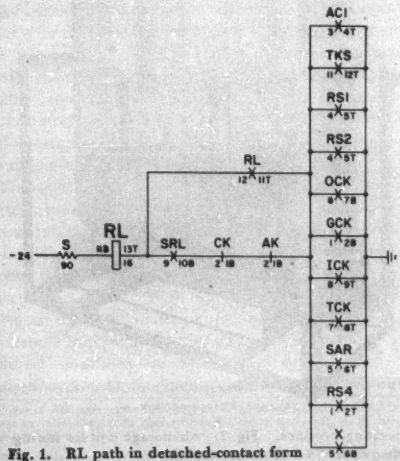


Fig. 1. RL path in detached-contact form

The *RL* path shown in Fig. 1 is part of a fairly complex circuit which, on the old type of drawing, appeared on seven different sheets. Depicted in the new form, it is immediately apparent that the operation of the *RL* relay requires that relays *CK* and *AK* be unoperated and that relay *SRL*, plus at least one of the 11 relays at the right of the figure, be operated. It is also apparent that having operated, the *RL* relay holds through its own locking contact (springs *11* and *12T*) independent of relays *SRL*, *CK*, and *AK* as long as any one of the other 11 relays remains operated. Functional schematic patterns are made up of circuit paths of this general type, and related paths are grouped together.

These functional circuit paths, called "functional schematics," completely disregard physical association of apparatus. However, this information is shown elsewhere on the drawing as apparatus figures showing apparatus components in their entirety but without wiring. These figures specify the apparatus content of an equipment unit. They also serve as an index for the scattered contacts in the circuit pattern, and show contact sequence of operation.

As an aid to understanding the circuit as a whole and as a key to the order of events in the operation of a circuit, a type of information known as "sequence charts" is included as part of the detached-contact-type circuit drawing. Sequence charts explain circuit action through the use of a compact graphical method, similar in some respects to a family tree or organization chart. In this manner the cause–effect relationship of events that take place in the circuit operation are clearly shown. A sequence chart takes the place of many pages of text material which have been used heretofore to describe circuit operation. Experience has shown that they make it possible to understand the circuit more quickly and easily. In addition, the time and effort required to obtain specific information is greatly reduced, with lower costs for training and maintenance.

The format adopted for the new drawings provides for all sheets to be drafted on tracings measuring 22 by 34 inches. When printed for general use, all sheets are reduced to 11 by 17 inches. The old drawings were odd sizes.

Experience, to date, with the new type of drawing has been most satisfactory and savings are being realized.

Digest of paper 55-467, "An Improved Detached-Contact Type of Schematic Circuit Drawing," recommended by the AIEE Committee on Communication Switching Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Scheduled for publication in AIEE *Communication and Electronics*, 1955.

F. T. Meyer is with Bell Telephone Laboratories, Inc., New York, N. Y.

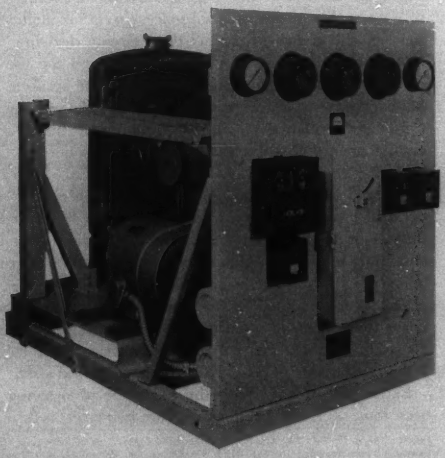
AIR-SUPPLY SYSTEM for Compressed-Air Circuit Breakers

J. E. SCHRAMECK
MEMBER AIEE

This system combines adequate storage capacity with compressor control which supplements this storage capacity permitting the use of all three compressors under conditions of high air demand, yet dividing load between the three compressors under normal air usage.

ADEQUACY, reliability, and flexibility are the principal requirements of an air system for supplying compressed air to compressed-air circuit breakers. The system must be adequate to supply all demands for air to the breakers due to system leakage and to breaker operations. It must be adequate in that it must have sufficient storage and compressor capacities so that emergency demands for relatively high rates of air consumption through breaker operations will not unduly overload the system or result in excessive running times on the compressors. The system must be reliable in that outages must be essentially nonexistent. Its reliability must be enhanced by relatively light duty on the compressors and with a sufficient number of compressors so that an outage on one compressor will not affect system operation. The system must be flexible in that it must provide for segregation of different parts of the system where trouble may develop and maintain the remainder of the system at maximum efficiency for conditions providing maximum air supply to the remaining system.

These considerations recently were applied in a new air-supply system at the Forbes Street Substation of Duquesne Light Company. This system was complicated to some extent by the need for supplying air at two different operating pressures since the substation contained 69-kv compressed-air circuit breakers operating at 260 pounds per square inch gauge (psig) and 14.4-kv breakers operating at 150 psig. This was different from most installations but simply required reducing valves in proper locations. The Duquesne Light Company System was classic in another respect in that the ultimate installation was to consist of 7 69-kv breakers and 30 14.4-kv breakers although, initially, only 4 69-kv and 16 14.4-kv breakers were to be installed. The fact that this station was built practically at the hub of the large Pittsburgh downtown metropolitan area was reason enough to be doubly certain that all considerations of adequacy, reliability, and flexibility should be made. Further consideration was given to provisions to supply a



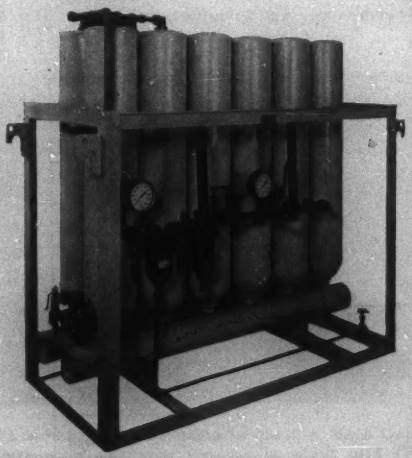


Fig. 1. Self-contained water-cooled air-supply unit for 1,000-psig operating pressure. Fig. 2. Air-storage unit for storing air at 1,000 psig hydrostatically tested at 1,800 psi. It utilizes 12 bottles, each of 1.5 cubic feet capacity

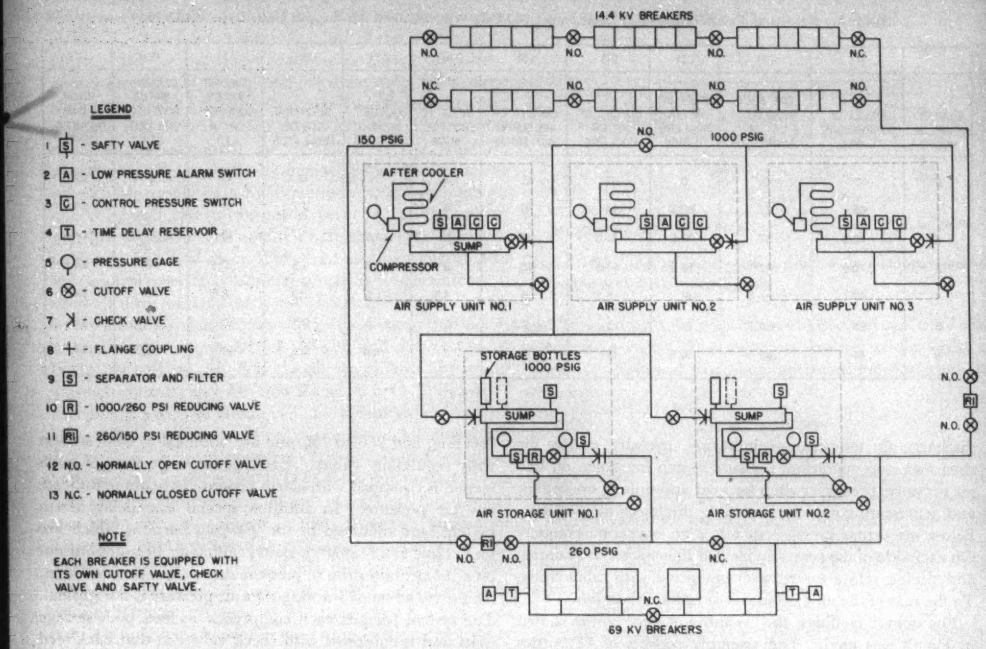

LEGEND
1 [S] - SAFTY VALVE
2 [A] - LOW PRESSURE ALARM SWITCH
3 [C] - CONTROL PRESSURE SWITCH
4 [T] - TIME DELAY RESERVOIR
5 - PRESSURE GAGE
6 - CUTOFF VALVE
7 - CHECK VALVE
8 - FLANGE COUPLING
9 [S] - SEPARATOR AND FILTER
10 [R] - 1000/260 PSI REDUCING VALVE
11 [RI] - 260/150 PSI REDUCING VALVE
12 N.O. - NORMALLY OPEN CUTOFF VALVE
13 N.C. - NORMALLY CLOSED CUTOFF VALVE
NOTE
EACH BREAKER IS EQUIPPED WITH ITS OWN CUTOFF VALVE, CHECK VALVE AND SAFTY VALVE.
14.4 KV BREAKERS
150 PSIG
1000 PSIG
AFTER COOLER
SUMP
COMPRESSOR
AIR SUPPLY UNIT NO.1
AIR SUPPLY UNIT NO.2
AIR SUPPLY UNIT NO.3
STORAGE BOTTLES 1000 PSIG
AIR STORAGE UNIT NO.1
AIR STORAGE UNIT NO.2
260 PSIG
69 KV BREAKERS

Fig. 3. Schematic of air-supply system for compressed-air circuit breakers

continual high air-leakage rate, since the 69-kv breakers are equipped with bleeder valves discharging air continuously through hollow support columns to prevent condensation on insulating surfaces.

Selection of a system operating pressure was made on the basis that 260-psig pressure was required to operate the 69-kv breakers and in order to utilize a cooling expansion process for drying air to the breakers a pressure higher than 260 psig was indicated. A higher compression pressure also enabled large quantities of free air to be stored in a smaller space. The availability of high-pressure gas-storage steel bottles and of a water-cooled compressor for high pressures permitted the selection of 900 to 1,000 psig as the system pressure, and this was done.

The selection of a water-cooled compressor was a departure from past practices for an installation of this kind. It was made primarily because of existing continuous-duty ratings for given capacities of air output; whereas, air-cooled compressors of the same capacities were rated on intermittent bases. With water cooling it appeared that lower air discharge temperatures would be obtained with a corresponding reduction in valve carbonization, and a reduced possibility of ignited carbon particles being carried over into the high-oxygen-content discharge air. Initial recognition was given to the possibilities that the cooling water supply would be unreliable or of poor quality and subject to freezing due to heating-system failure. Accordingly a self-contained water-cooling system was incorporated, using a circulating pump and a fan-cooled radiator driven by belts from the compressor motor. With these additions, the unit became self-contained and could be filled with antifreeze solution.

From the preceding considerations an air-supply unit, with no storage, as shown in Fig. 1, was designed. The unit is complete with controls for automatic operation, finned after-cooler for the discharge air, and sumps for collecting condensate. It consists, essentially, of a 2-stage compressor driven by a 15-hp motor to deliver 24 cubic feet per minute of free air at a pressure of 1,000 psig. The unit was set up for dual automatic operation. That is, a pressure switch is provided to open the holding coil at the line-starter for automatic de-energization at 950 psig and to re-energize the line-starter at a lower pressure. In addition, a second pressure switch is provided to de-energize the magnetic unloader at 1,000 psig if for some reason the first pressure switch and line-starter have not functioned. In other words, pressure switch no. *1* causes the unit to start and stop, while pressure switch no. *2* loads and unloads the compressor with air usage.

The control panel of the air-supply unit is shown in Fig. 1. The instruments mounted across the top of the panel are a

Full text of conference paper CP55-227, presented before a session of the AIEE Committee on Switchgear, AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955.

J. E. Schrameck is with the Westinghouse Electric Corporation, East Pittsburgh, Pa.

Table I. Results of Temperature-Rise Tests on a 1,000-Psig Water-Cooled Air-Supply Unit, Type CA37-1000

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ELAPSED TIME IN HOURS	OUTLET OF COMPRESSOR °C RISE	ONE FOOT FROM OUTLET OF COMPRESSOR	INLET OF AFTER-COOLERS °C RISE	OUTLET OF AFTER-COOLERS	OUTLET OF AIR SUPPLY UNIT SUMPS	INLET TO BOTTLE SUMP	OUTLET OF BOTTLES	DISCHARGE SIDE OF REGULATOR	COOLING WATER COMPRESSOR INLET	COOLING WATER COMPRESSOR OUTLET	ROOM TEMP. DEGREES CENTI.
0	0	0	0	0	0	0	0	0	0	0	22
1	68	83	20.5	14	10	5	3	1	10	11	24
2	72.5	87	19.5	14.5	10	6	2.5	1	10	11.5	24.5
3	70.5	87	19.5	14.5	10	6	2.5	1.5	10.5	12	24.5
4	67	85.5	18	13.5	9	4.5	1.5	0.5	9.5	11	26
5	65	84.5	18	13	9.5	5	1.5	0.5	10	11	26
6	61	82	18.5	13	9	5	1.5	0.5	10	11	26

discharge-air temperature indicator, pressure switch for start and stop operation, pressure switch for alarm on low air pressure, pressure switch for load and unload operation, and a pressure gauge for recording discharge air pressure. Below the center pressure switch is an operation counter. On each side of the centrally located line-starter are control and timing relays for parallel operation with other units. To the rear of the unit is shown the radiator and fan.

For storage facilities, the assembly of steel bottles shown in Fig. 2 was used. The assembly consists of 12 bottles each of 1.5 cubic feet capacity and equipped with safety valves, line and storage pressure gauges, sumps, filter and moisture removal unit, and necessary check and cutoff valves. This assembled unit including the air-supply-unit piping was designed for 1,000-psig working pressure and were hydrostatically tested at 1,800 psig.

TEST RESULTS

One air-supply unit was connected to one air-storage unit for test. The time required to compress from atmospheric pressure to 950 psig was 68 minutes. Seven minutes of compressor running time were required to pump from the selected cut-in point of 850 psig to the cutout point of 950 psig. Table I shows temperature rises at various points in the system during a 6-hour temperature test. The system was pumped to 950 psig and then a valve was opened to balance compressor pumping rate. The system then was maintained at 950 psig until 6 hours of continuous compressor operation had elapsed. The highest temperature rise was 87 C and occurred in the piping approximately 1 foot away from the compressor discharge.

THE INTEGRATED SYSTEM

Final selection of the system for the Duquesne Light Company consisted of three air-supply units and two air-storage units as shown in Fig. 3. This system is designed so that normally one half of the 69-kv breakers and one half of the 14.4-kv breakers are supplied from each storage unit and may be segregated by means of manually operable cutoff valves. Successive pressure reductions of 950 to 260 psig, and 260 to 150 psig are obtained in each section with regulating valves. Each pressure portion of each section is equipped with alarm pressure switches to indicate low air pressure. In addition special time-delay alarm switches are mounted in the 260-psig portions which are set to close at 230 psig for slowly falling air pressure but not on a momentary drop in pressure due to breaker operation. This gives advance warning that air pressure is not normal. The system permits each compressor to feed both storage units and is equipped with check valves so that back feed is not possible.

Calculations indicate that for normal system leakage and for air bleeding to maintain dry insulation of the 69-kv breakers, and for the final installation of 30 14.4-kv breakers and 7 69-kv breakers, the air requirement will be 8 cubic feet per minute of free air continuously. Thus one compressor running 20 minutes per hour will make up the system leakage requirement. Also, approximately 300 cubic feet of free air are required to fill the storage units in raising their pressure from a cut-in point of 850 psig to the cutout point of 950 psig, which required 19.5 minutes of compressor running time when continuous system leakage is subtracted from the compressor output. It follows that one compressor will operate once per hour to supply system leakage.

The system storage is sufficient for 25 operations of the 69-kv breakers or 192 operations of the 14.4-kv breakers. With the system fully charged, it will supply normal system leakage and total air bleeding for the ultimate installation for a period in excess of 8 hours before the low air-pressure point for the 69-kv breakers is reached. An additional 21 hours will elapse before the same pressure condition exists for the 14.4-kv breakers.

Initially the system was laid out for two air-supply units and two air-storage units, since one continuously rated compressor operating one third of the time would be sufficient and a second unit would serve as a stand-by. However, it was decided that due to the size of this substation a third unit would be included, thus insuring continuous stand-by capacity.

In order to minimize wear and distribute it evenly over the three air-supply units, a control scheme for alternate

compressor operation was devised. This scheme is shown in Fig. 4. The fundamental objective of this scheme is to operate each of the three compressors during an 8-hour period for each 24 hours. At the same time, since three compressors were available the scheme was designed so that a second and then the third compressor would start automatically for abnormal air demands. These functions were obtained electrically by mounting two control relays on each air-supply unit, by mounting a sequence timer on one unit, and setting the cut-in point of the controlling pressure switch on each unit at a different value. Thus referring to Fig. 4, if timer *T* is closed on timer circuit *A* so that control relay *MG1* is energized on air-supply unit no. *1*, then all three contacts *MG1* are closed completing circuits to no. *2* and no. *3* air-supply units as well as on unit no. *1*, so that control relays *MG1A*, *MG2A*, and *MG3A* can be energized. If contact *B* is closed, the circuits are set up through control relay *MG2* on the no. *2* unit. With *MG1* contacts closed, the circuit will be completed to control relay *MG1A* provided control pressure switch contact *PS1* is closed at its cut-in pressure. If *PS2* and *PS3* are open, only unit no. *1* will operate. If *PS2* is closed, unit no. *2* also will operate, and similarly for unit no. *3*, since the *A* relays are equipped with contacts in their respective line-starter circuits. This assumes that *PS1* is set to close when line pressure on unit no. *1* drops to 850 psig while *PS2* and *PS3* are set at 800 and 750 psig, respectively. All three pressure-switch contacts open at 950 psig. For 8 hours, contact *A* is maintained and unit no. *1* supplies air to the system. At the end of 8 hours, *A* opens and *B* closes so that the *MG2* contacts close. The circuit then completes to the *A* relay on unit no. *2* through *PS1* and this unit will operate during the next 8 hours to supply system air demands. During this period, unit no. *1* will respond to *PS3* and unit no. *3* will respond to *PS2*. Thus sequential control of the units is obtained along with combined operation for abnormal air demands.

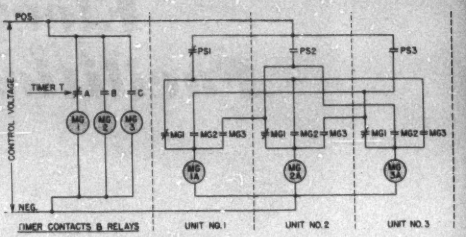


Fig. 4. Schematic of compressor control for parallel operation of three water-cooled air-supply units

CONCLUSIONS

THE DESCRIBED AIR-SUPPLY SYSTEM for compressed-air circuit breakers combines adequate storage capacity with compressor control supplementing this storage capacity so as to provide the use of all three compressors under conditions of high air demand, yet dividing load between the three compressors under normal air usage. The system provides flexible use of piping, pressures, and compressor and storage capacities through sectionalizing valves located to isolate different sections of the system. Reasonably foreseeable demands for air use at this station are met by the initial air-system installation. Self-contained water-cooled compressors will supply all air requirements with negligible temperature rises for this system.

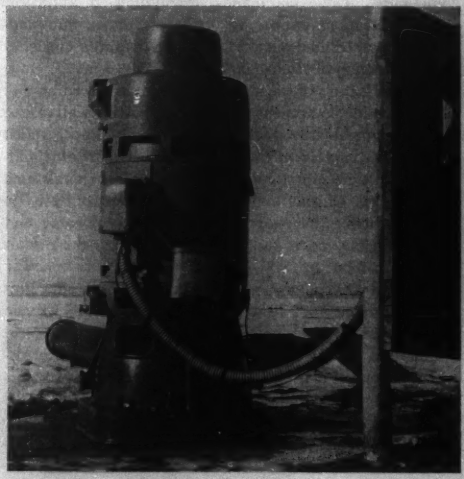
Hollow-Shaft Vertical Motors for Pumping

A new line of hollow-shaft vertical motors designed for the pumping industry has been announced by the General Electric Company.

Available in ratings of 40 hp and up, in frame sizes 404 through 6330, and in ratings from $7\frac{1}{2}$ hp and up in early 1956, the new line of motors represents a complete redesigning of all major parts.

Installation, inspection, and maintenance has been made easier by using a lightweight cap (made of aluminum in the larger sizes) which can be lifted by one man. When the cap is removed, couplings and bearings are available for inspection, and all installation attachments and impeller adjustments can be made without further disassembly.

Lubrication is simplified by a new Vistamatic lubrication center providing an oil gauge which can be read easily, and ample filler and drain plugs to facilitate adding and draining lubricant quickly with little chance of danger to the motor. A large-capacity oil reservoir helps prolong lubricant life, and a machined metering hole supplies lubricant to the bearings at all times. During idle periods, the bearings are completely submerged to inhibit rusting.



Electronic Facilities Control

J. J. DE MATTTEIS

A central control system is described which follows preset programs and automatically switches on or off up to 40 groups of remote operations—each on its own time schedule. Utilizing carrier current signals, it operates over existing electric circuits and does not require the installation of any transmission wiring.

THIS CENTRAL CONTROL SYSTEM, described as an "electronic supervisor"—a big step in the trend toward automation—provides economical remote control of facilities such as lights, motors, and valves within a plant or institution. Using carrier current signals and operating over existing electric circuits, the system does not require the installation of a single transmission wire. Fig. 1 shows a possible industrial plant application.

The physical plant or institution covered by the system may involve a single building or several buildings scattered over many acres. Components and operation of the system are simple in design and character. By superimposing electronic pulses of from 2,106 to 19,000 cycles on the plant electric distribution system, the same lines which provide 60-cycle current for operation of numerous electric devices can be used to transmit remote-control signals. Thus, the electric current which causes a motor to turn, or a valve to open, carries with it its own "invisible" start and stop commands. These commands, originating in a flexible central operations panel, may be programmed automatically on a schedule designed to provide optimum efficiency in the operation of electric facilities.

Another feature of the system is that time recording and time indicating equipment, including secondary wall clocks, may be automatically synchronized with a radio-controlled master clock supervised by the National Bureau of Standards' radio time signals. In addition, audible signals such as the plant whistle may be sounded electronically to indicate starting and stopping times in the morning and evening and at lunch and rest periods during the day as well—all without special wiring.

In the carrier system, an electronic or rotary transmitter is coupled to the 60-cycle a-c lines at the distribution voltage to assure complete power system coverage. Typical installations include signal injection into a-c electric distribution systems of from 110 to 13,800 volts. In the majority of electric systems, satisfactory coverage is obtained by coupling directly to the 115-volt lighting distribution system. In some instances, however, plant-wide coverage requires coupling to high-voltage distribution systems of up to 13,800 volts and frequently may involve areas of many square miles. In either case, this system assures complete coverage for electronic remote control.

The system is capable of transmitting and executing 40 ON and 40 OFF commands by use of only four carrier frequencies. The system employs a unique encoding device at the central control, see Fig. 2, and an electromechanical decoding device, see Fig. 3, at remote locations which responds to coded pulses of the proper frequency.

CENTRAL OPERATIONS PANEL

THE CENTRAL OPERATIONS PANEL is the source of the system's directions or commands. Program machines are provided for automatic scheduling of operations on a weekly basis. The schedule may be varied automatically for any day of the week. Saturday and Sunday operations, for example, may be on an entirely different schedule than those of weekdays.

Inactivating switches and bull's-eye lights are associated with each ON-OFF circuit. The switches provide a ready means for making any programmed circuit inoperative to prevent transmission of command pulses normally scheduled for a circuit. The bull's-eye lights indicate which commands were last transmitted on each circuit. When the light associated with a particular circuit is illuminated, an ON command has been transmitted. When the light is out, an OFF command has been transmitted. In addition, a manual control section is provided for initiating commands manually on a nonscheduled basis and also to change the status of circuits normally operating on a prescheduled basis. Interlocks preclude possibility of a manually initiated signal interfering with one that may be automatically scheduled at the same instant, and conversely.

A sensing unit in the central operations panel automatically detects and decodes the carrier signal. In the event the transmitter fails to key, or if it fails to transmit a signal of sufficient voltage level to reach all remote units connected to the system, the sensing unit will prevent changes in the indicating lights associated with each circuit. The sensing unit trigger voltage is readily adjusted by means of a potentiometer to a value which assures a strong carrier signal for every active 115-volt line.

Extra or repetitive commands may be scheduled throughout the day to restore to an ON or OFF status, as required,

A special article recommended for publication by the AIEE Committee on Industrial Control.

J. J. De Matteis is with the International Business Machine Corporation, New York, N. Y.

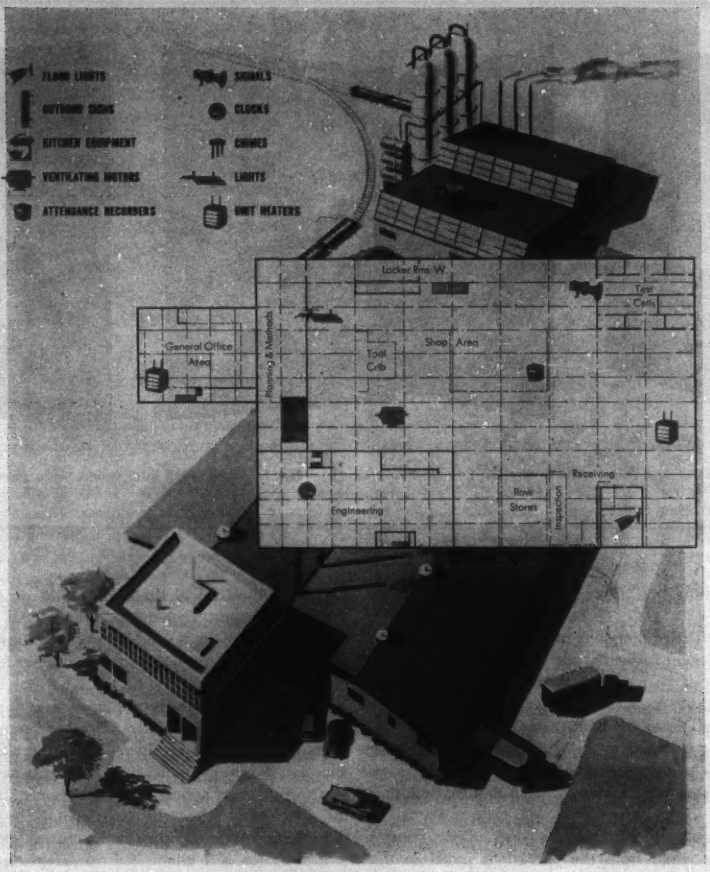


Fig. 1. A possible industrial plant installation

any remote unit that may have been operated manually for periods not included in the prescheduled program. The coded relays also provide lock-out to prevent unauthorized switching at the remote point.

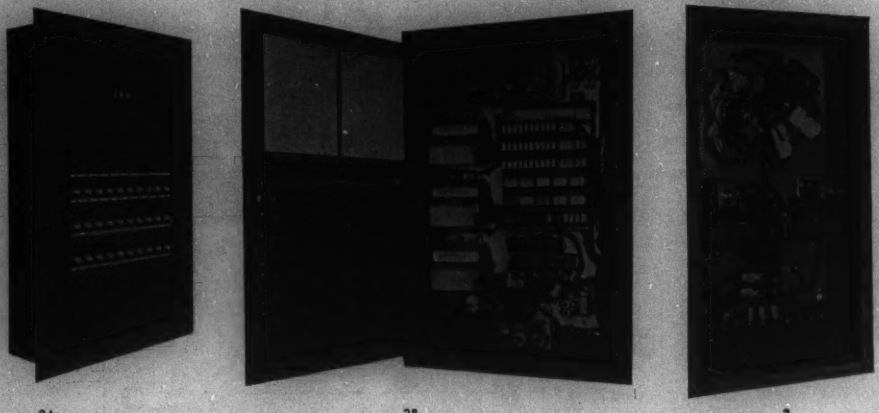
An important feature of the central operations panel is the "building block" basis of its design. Program machines are pluggable, as are the circuit relays. In addition, a plugboard is provided to facilitate future changes in circuit arrangement or capacity. Other features include a red bull's-eye light to indicate that power is on and an amber bull's-eye light to indicate if an ON or an OFF function is being transmitted. All lights flicker when the panel is busy transmitting commands.

TRANSMITTING EQUIPMENT

ELECTRONIC CONTROL of operational services by a central control system generally is the most desirable. Savings realized in wiring alone—since no special control wires are required—support the use of the electronic medium. Transmitting equipment, an essential part of electronic control, is available to meet requirements for abundant carrier signal energy.

Installations of electronic time and program systems include tube transmitters, amplifiers, and rotary generators. Transmitters and generators may be coupled to low-voltage lighting circuits or to high-voltage power distribution systems. When coupled to high-voltage 60-cycle lines, signals feed through transformer banks to each 115-volt feeder on the system.

Tube transmitters are capacitor coupled to electric systems of up to 600 volts. An output transformer provides means for impedance matching. Rotary generators are normally employed in electric distribution systems of 2,300 to 13,800 volts. Tuning coils, drain coils, spark gaps,



2A 2B 3

Fig. 2. Central operations panel: exterior (A) and interior (B). Fig. 3. Type 4053 dual coded relay shown with its cover removed

coupling capacitors, and appropriate fuses and disconnects are provided.

Among more than 7,000 users of this electronic time and program equipment, systems are installed which cover industrial areas of 10 to a 100 square miles while others cover comparatively small plant areas.

The scope of installation of these electronic systems, however, is not confined to industrial plants. They are used extensively in large and small schools and universities, commercial and public buildings, and multistoried skyscrapers.

Central control systems also may operate via control circuits directly wired from the operations panel to the terminal unit. This means of control may be advisable when spare wires of the required size are installed in cables run throughout a building or plant. A single pair of control wires will provide control of ten ON-OFF circuits. Each additional wire available will increase the number of control circuits by ten.

ELECTRONIC DUAL CODED RELAYS

THE DUAL CODED RELAYS in the system consist of a basic electronic receiver, electromechanical decoding device, and load relays. Basic electronic receivers connected to 60-cycle outlets in the system reject all frequencies except those to which they are tuned. When a signal of correct frequency is detected, it is amplified and applied to a cold-cathode tube. The cold-cathode trigger tube "fires" and in so doing conducts current through a magnet or relay to perform any of a number of functions. The basic receiver requires only five electronic components: two capacitors, two coils, and a cold-cathode tube. There are no hot filaments to burn out. In addition to the electronic components, the receivers may contain a magnet and associated mechanical time-delay unit, or a relay and a simple electronic time-delay circuit. All receivers incorporate a time-delay unit, either electronic or mechanical, which rejects the usual short line transients found on many distribution systems. See Fig. 4.

The dual coded relay is capable of distinguishing between any one of ten ON and ten OFF codes on the same frequency. The basic receiver detects the electronic pulses and actuates the decoding unit. If electronic pulses of the correct frequency appear at properly spaced time intervals, the dual coded relay will cause an ON or OFF function to be performed as directed by the central operations panel. A load switch is available for manual control of the load from the coded relay. A key-operated control switch is also available for locking out the electronic pulses, for making the load switch inactive, or both.

Circuits are identified by channel and by circuit code. The channel is represented by a letter (*A*, *B*, *C*, *D*) and the circuit by a numeral (*1*, *2*, *3*, *4*, etc.). As many as ten circuits are thus made available on each channel, as follows:

A-1 through *A-10*
B-1 through *B-10*
C-1 through *C-10*
D-1 through *D-10*

The decoder is quite simple, as may be seen by examining the illustrations. Basically, it consists of a motor-driven cup with a gate designed to accept signals which are properly coded.

The decoder is shown in its normal "Rest" position in Fig. 5-I. The signal contacts are normally "Open," as are the motor contacts. The receiver shown is associ-

ated with circuit *B-2*. The letter is an indication of the frequency to which the receiver is tuned and the numeral indicates the position of the decoder gate. When an electronic START pulse at the correct frequency is detected by the receiver, the motor contacts close by action of a selection magnet, not shown on the diagram. If this signal is less than 2 seconds long, it is rejected. However, if it is approximately 3 seconds or longer, the motor will turn the decoding cup sufficiently to move the motor cam into such a position as to keep the motor contacts closed. This may be seen in Fig. 5-II. Although the initial START pulse may have terminated, the decoder maintains its own motor holding circuit for one complete revolution of the cup, which requires 60 seconds. Following the START pulse, selection pulses may be transmitted at 5-second intervals, as required, to select circuits *1*, *2*, *3*, etc., up to a maximum of ten circuits on each frequency. With each pulse, the selection magnet is energized and attempts to pull the signal contact lever into the gate. The duration of the selection pulse is 3 seconds. The gate position, and thus the circuit, is readily changed from one position to another in each receiver.

In Fig. 5-I the signal contact lever is resting in its normal position away from the periphery of the cup. However, when a signal is detected, it is driven against the cup in an effort to locate the gate. The lever making just such an effort to enter the gate is shown in Fig. 5-II. In this case, the signal happens to be timed for circuit *B-1*, frequency *B*, code *1*, and is rejected since the decoder shown is set for circuit *B-2*. Fig. 5-III shows the action when a signal appears just as the cup has rotated sufficiently to align the gate with the signal contact lever: the lever enters the gate and, as shown in Fig. 5-IV, cannot escape. Notice that the signal duration cam rotates with the cup and is approaching the signal contact lever. Fig. 5-V shows the contact lever actuated by the signal duration cam, resulting in closure of the signal contacts. It is during this interval that the control circuit is energized. Fig. 5-VI shows the decoder at rest once again as the motor cam has released

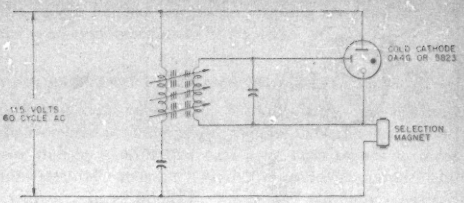


Fig. 4. Schematic showing operation of the electronic receiver

the motor contact. At the next START pulse, the decoder will rotate once again. If a selection pulse timed to correspond with gate *2* does not appear, the contact lever then will escape through the gate. This in turn is responsible for preventing a signal circuit closure the next time around.

Fig. 6 shows how the receiver differentiates between ON and OFF functions. The selection magnet is energized each time that a signal of the correct frequency appears on the 60-cycle a-c lines. The magnet performs three functions:

1. It starts the decoding device motor.
2. It attempts to pull the signal contact lever into the decoder gate.
3. It differentiates between ON and OFF functions.

Normally, there is no electronic pulse on the distribution system between the 56th and 58th second, at which time the signal duration cam is closed, and therefore the selection magnet is not energized. See Fig. 6*A*. At the 56th second, then, a circuit is closed from the 115-volt source through the upper contact points, to the transfer contact point (middle strap) of the selection magnet contacts, thence to the OFF function relay coil.

If, however, an ON pulse appears on the distribution

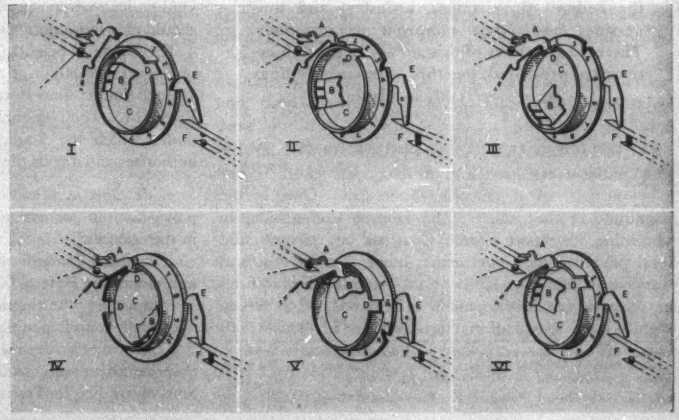


Fig. 5. Coded receiver operation: *A—Signal contact lever and contacts; B—Signal duration cam; C—Decoding cup; D—Gate; E—Motor cam; F—Motor contacts*

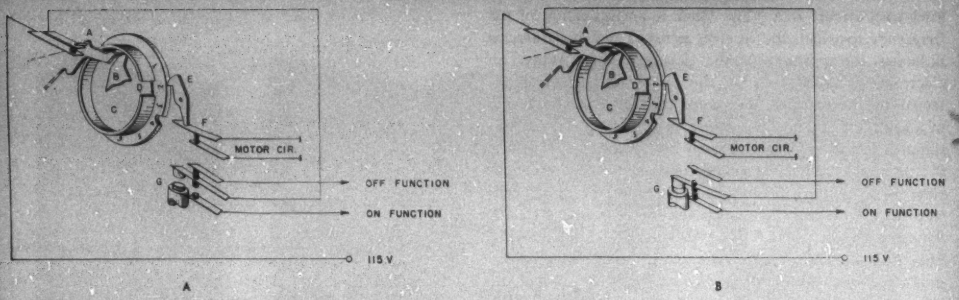


Fig. 6. OFF function (A) and ON function (B) of the coded receiver: *A—Signal contact lever and contacts; B—Signal duration cam; C—Decoding cup; D—Gate; E—Motor cam; F—Motor contacts; G—Selection magnet*

system between the 55th and the 59th second, the selection magnet will transfer the 115-volt source to the ON function. See Fig. 6*B*. Thus, the dual coded relay operates on a 3-pulse basis: a START pulse, to start the decoder motor; a selection pulse, to select a given gate (circuit); and, if an ON function is to be performed, a third pulse to select the ON function. Absence of the third pulse indicates an OFF function is to be performed.

A National Survey of Scientific Research and Development

A. T. WATERMAN
MEMBER AIEE

A series of studies now being carried on by the National Science Foundation will constitute, when completed, an over-all survey of research and development in the United States, including the Federal Government, industry, and universities and other nonprofit organizations. The broad outlines of this survey and its objectives are presented, together with such findings as are currently available.

A CRITICAL AND ANALYTICAL LOOK at the nation's research and development effort is important for a number of reasons. One is the magnitude of that effort. The Hoover Commission, in submitting its report to the Congress on research and development in the Government, noted that for the fiscal year beginning July 1, the total national expenditures for research and development will exceed $4^1/_2$ billion. Slightly more than half of the total cost ($2,400,000,000) will be borne by the Federal Government. In terms of costs alone, it makes good sense to know for what the money is being spent, by whom, and under what circumstances. The information is prerequisite to sound decisions in such vital policy questions as what role the Federal Government should play in support of science.

The National Science Foundation has two mandates for undertaking a study of research and development in the United States: one from the Congress and one from the President. The National Science Foundation Act of 1950, under which the Foundation was created by Congress, authorizes and directs the Foundation to:

...develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;

...evaluate scientific research programs undertaken by agencies of the Federal Government;

...appraise the impact of research upon industrial development and upon the general welfare;

...provide a central clearinghouse for information covering all scientific and technical personnel in the United States including its Territories and possessions.

Essentially full text of an address presented before the Sixth Annual Conference on Industrial Research, Columbia University, New York, N. Y., June 6, 1955, and recommended for publication by the AIEE Committee on Research.

A. T. Waterman is director, National Science Foundation, Washington, D. C.

All of these functions relate to the fact-gathering activities of the Foundation and are in addition to the Foundation's other major responsibilities for the support and encouragement of basic research and education in the sciences.

On March 17, 1954, the President issued an Executive Order clarifying responsibilities of the Federal Government in the area of scientific research and specifically charging the National Science Foundation with certain responsibilities including the following: "The Foundation shall continue to make comprehensive studies and recommendations regarding the nation's scientific research effort and its resources for scientific activities, including facilities and scientific personnel, and its foreseeable scientific needs, with particular attention to the extent of the Federal Government's activities and the resulting effects upon trained scientific personnel."

In discharging its responsibilities under these two mandates, the Foundation has undertaken to do what has never been done before and that is to make a comprehensive survey of the status of research and development throughout the United States.

Over the last two decades several significant studies have directed attention to the growing influence of research and development on our national life and emphasized the need for a better understanding of research and development and for conscious planning in its organization and administration. In 1938 the National Resources Committee submitted a report to the President entitled "Research, a National Resource," which recommended "that further studies be undertaken for the purpose of making a comprehensive review of the research resources of the United States, such as those of: (*a*) industrial laboratories, (*b*) business organizations, (*c*) social and welfare agencies, (*d*) private institutions, (*e*) state and local governments in co-operation with state and regional planning boards." To a remarkable extent, this recommendation anticipates the scope of the present survey.

Ten years ago, in July 1945, Dr. Vannevar Bush submitted to the President his now-famous report, "Science, the Endless Frontier." This report considered the status of research and development in the United States at the close of World War II and made a series of recommendations respecting it, including the establishment of the National Science Foundation. Two years later, in August 1947, John R. Steelman, chairman of the President's Scientific Research Board, submitted his report, "Science and Public Policy: A Program for the Nation," which also urged the creation of a national science foundation.

As the National Science Foundation gradually assumed shape, following its establishment in May 1950, it soon became apparent to the staff that one of its own most pressing needs, particularly in the formulation of national science policy, was for a much greater knowledge concerning the extent and kind of the national research and development effort. We have undertaken a broad survey of science and its related activities in the United States in three major categories: (1) research programs in the Federal Government; (2) research at nonprofit institutions; (3) research in industry. We are also studying progress in the various fields of science and making a special study of the economic implications of research.

RESEARCH PROGRAMS OF FEDERAL FUNDS

THE SURVEY began with a study of the research and development activities of the Federal Government. In all our studies, quantitative data have been sought in three fundamental categories: funds, scientific manpower, and facilities. In addition, we have been especially interested in the relative apportionment of effect between basic and applied research.

The dimensions of the Federal research and development budget is one important reason for analyzing in some detail the ways in which these public funds are put to use. According to the U.S. Budget Document, net budget expenditures for research and development programs of the Federal Government are estimated at $2,218,000,000 for fiscal year ending June 30, 1956. This represents an increase of $147,000,000 over 1955 and $123,000,000 over 1954. These amounts include expenditures for the conduct of research and for increase of research and development plant. The National Science Foundation estimates that basic research accounts for less than 7 per cent of the total.

Beginning in 1952 the National Science Foundation inaugurated a continuing study under the general title: "Federal Funds for Science." Three volumes have been issued to date. Volume 1 is an analysis of Federal funds for scientific research and development at nonprofit institutions for the years 1950–51 and 1951–52. Volumes 2 and 3 are factual studies of the Federal research and development budget for fiscal years 1952 through 1955. Volume 4, covering fiscal years 1954, 1955, and 1956, is in preparation.

The data presented in these and other studies of the Federal research budget are presented by agency and major subdivision, by scientific activity component and performing component, by funds applied for conduct of research and development only, and by funds applied to basic research only, and by scientific fields. Out of the details of the manner in which the Federal research and development budget is administered, several large and rather significant factors emerge. For example, of the 56 departments and agencies of the executive branch of the Federal Government, about 20 reported funds for scientific research and development, and seven of these accounted for over 98 per cent of the total funds. Considered as one reporting unit, the Department of Defense alone administers about three fourths of the total. The low proportion allocated to basic research has already been mentioned. Only two of the 20 agencies, National Science Foundation and the Smithsonian Institution, use their total research funds for basic investigations.

In view of the interest expressed in trends in Federal expenditures for research and development, the Foundation has undertaken a historical summary of Federal funds for science for the period of 1900 and 1954. Another study that is expected to be of considerable interest is an analysis of the Federal financing of higher education. Statistical data have been gathered on Federal scholarships, fellowships, research assistantships, traineeships, extramural in-

service training programs, and training by the Veterans Administration under the G.I. acts of 1944 and 1952.

Federal Organization for Conduct of Scientific Activities. Considering the breadth and diversity of the scientific activities of the Federal Government, it is perhaps surprising that information concerning those activities has never been collected and published in a single document. To fill this gap, the Foundation is preparing an organizational directory covering all Federal agencies with scientific activities, subdivided to approximately the bureau level. The directory will include for each agency a statement of its general mission, statement of research mission, and other pertinent data.

The importance of agricultural research as one of the oldest and most significant research activities of the Federal Government has prompted a special study of the agricultural experiment stations in co-operation with the U.S. Department of Agriculture. This study will probably not be completed until late in the year.

Manpower Engaged in Scientific Activities. In all of the studies mentioned thus far, scientific manpower is an important consideration. Any discussion of expenditures for research and development purposes must necessarily take into account the numbers of scientific and technical personnel employed. For greater convenience and ease in reference, the most significant data on scientific manpower in the Federal Government are being compiled in a separate monograph. The data will be presented by agency and will also include information on military personnel engaged in scientific activities.

History of Federal Activities in Science. A curious lacuna in the relationship between the U.S. Government and science has been the absence of any definitive study of the history of the growth of that relationship. However, a "History of the Activities of the Federal Government in Science, 1789–1940" is nearing completion. Under contract between the National Science Foundation and the American Academy of Arts and Sciences, the history is being written by Dr. Hunter Dupree.

Survey of State Government Research. Although much has been spoken and written on the whole subject of research support by the Federal Government, comparatively little attention has been given to the research being supported by the states. Accordingly the Foundation has entered into contract with the University of North Carolina for a study of state-supported research in six state governments: North Carolina, Connecticut, New York, Wisconsin, New Mexico, and California. The data gathered include funds, manpower, program, and organizational information on all scientific activities. This study has not yet been completed and it is therefore too early to predict the results. However, preliminary drafts suggest that the dollar volume of state-supported research and development will probably be considerably higher than was anticipated.

RESEARCH AT NONPROFIT INSTITUTIONS

A SECOND MAJOR PHASE of the Foundation's survey is directed toward research in nonprofit institutions. These include colleges and universities, affiliated research institutes, philanthropic foundations, hospitals, and clinics. The survey covers four main areas: (1) research expenditures in universities; (2) financial support of graduate students; (3) faculty and research manpower in the universities; and (4) research support by foundations. The first three studies are being made by the staff. The study of research support by foundations has been made by the Russell Sage Foundation without cost to the Government.

The study of the financial support of graduate students is nearing completion. Because the graduate-student population is the immediate source for trained scientists and engineers, as well as for leadership in other fields, it is important that as much as possible be known about its numbers and composition and the extent to which the present system of financial support is adequate. Such data as these are immediately useful to the Foundation in charting the future course of its fellowship program and in guiding decisions with respect to scholarships.

It may be of interest to note in passing that during the survey year, 1954, the total graduate-student population numbered 225,000. Our survey covered approximately 152,000 of these, in all fields except law, theology, clinical medicine, dentistry, and nursing. Twenty-five per cent of all the graduate students in the survey held teaching or research assistantships or fellowships in April 1954. Twenty per cent of the students in the survey were enrolled in the natural sciences. This figure is of special interest because it gives an approximate idea of the base from which the supply of future scientists will be drawn. A bulletin covering highlights of this survey is presently in preparation and the full report will be issued later.

The studies on research expenditures in universities and faculty and research manpower in the universities have not progressed to the point where it is appropriate to comment upon them. However, the Russell Sage Foundation has furnished the preliminary draft of its report on "Foundation Expenditures for Scientific Research." As the philanthropic foundations for many years constituted one of the principal sources of support for scientific research, some of its findings are of more than ordinary interest. Although some 4,500 foundations exist that have more than negligible assets, Russell Sage limited its study to 77 of the larger foundations whose assets in general total $10 million or more. The 77 had total assets of just above $3 billion in 1953, from which they received an income of $166 million. Of the $142 million expended for program, only $26 million, or about 16 per cent, of the total expenditures of these foundations went for scientific research and development. In fact, only 43, or slightly more than half of the 75 foundations that itemized their expenditures, supported scientific research at all.

With appropriate warnings about the dangers of generalizations, the report nevertheless notes two significant trends in the research programs supported by the philanthropic foundations: first, a diminution in the amount of scientific research supported by the foundations in comparison with other fields of study; and second, a trend away from the support of basic research toward applied research and development. The report asserts, "Except in biological

research, where in all years nearly the whole contribution was classified as basic, all branches of science showed a trend toward applied research and development." In view of the present crucial importance of basic research to the national welfare, this finding is of special significance in the over-all picture of research support in the United States.

RESEARCH IN INDUSTRY

INDUSTRIAL RESEARCH is the largest part of the national research effort. Industry conducts approximately 65 per cent, or $2.5 billion out of a total of $3.9 billion. Federal and state funds finance 55 per cent and industry 42 per cent of this total. The research done in the laboratories of the Federal Government amounts to only about $700 million.

Our industrial survey covers the research and development activities of industrial organizations, research institutes not affiliated with universities, commercial laboratories, co-operative research organizations, trade associations, professional societies, and a few miscellaneous organizations with minor research functions.

Research by Industrial Organizations. The survey of manufacturing and nonmanufacturing industries, which is being made for the Foundation by the Bureau of Labor Statistics, covers approximately 12,000 companies. The sampling frame was developed from the company file of the Bureau of Old Age and Survivors Insurance. Included in the survey have been all companies with 1,000 or more employees and a sampling of smaller companies based upon the estimated research propensities of their particular industries. The survey is in two parts: (1) a questionnaire designed to elicit raw quantitative data, mailed to all the companies; and (2) personal interviews with research directors, designed to elicit nonquantitative data from about 200 companies with substantial programs in research and development.

Unfortunately, over-all data from this survey are not yet available. Preliminary data relating to manpower shortages have only just been received, and will be referred to presently. Meanwhile, it is of interest that the rate of response in the industrial survey is in itself an item of note. It runs around 87 per cent, a rate at least 50 per cent higher than the responses to the few similar studies of less scope that have been done in the past. The high degree of interest and co-operation thus evidenced by industry not only assures the greater validity of the results of the survey but is evidence of the growing research consciousness of industrial leaders.

Research by Trade Association. The research being done by trade associations, professional societies, and other co-operative groups has been reported upon by the Battelle Memorial Institute in a preliminary way. The area of research covered by this report is one of great diversity and interest. It suggests the colorful variety of our huge industrial complex and at the same time is indicative of the ingenuity with which Americans attack common problems. From it, one learns unusual and unexpected facts. For example, the American Trade Association Executives bestowed an award of merit to the National Institute of Diaper Services, Inc., in 1954 "for its successful compaign to set and maintain high levels of sanitary control in this comparatively new industry." One finds that the Colorado Flower Growers Association has experienced a 50-per-cent increase in flower productivity since it inaugurated a program of planned research in 1936. Following the Armour Institute's successful investigation for possible replacements for palm oil, the price of palm oil dropped 25¢ per pound and the savings to steel companies in the first year have been estimated as equivalent to the cost of 10 years of research effort by the American Iron and Steel Institute.

The Trade Association Division in the Department of Commerce estimates that there are 16,000 organizations of businessmen in the United States. The National Research Council counts some 1,300 scientific or technical institutions. Allowing for some overlap between these groups, the Battelle survey covers approximately 16,500 groups. Dollarwise, the trade groups, including farmers' co-operatives, trade associations, and industrial research co-operatives, supported research and development to the extent of about $17 million in 1953. Of this amount, roughly 20 per cent, or about $3,250,000, was reported for basic research as against $11,800,000 for applied research and development. The professional associations and societies supported research to the extent of about $3,600,000 in 1953, and about 68 per cent of these funds went for basic research.

One does not attempt to evaluate the relative importance of the two types of research on the basis of the dollars invested, however. Battelle reports that during personal interviews many examples were given of basic research that answered specific industry problems. As an example, the report cites a basic research project, being conducted by the American Petroleum Institute, involving the forms of equilibrium that can exist between liquid petroleum and gaseous products, particularly at high temperatures and high pressures. Some interesting results of the project became available about the time that refining companies were having difficulties with high-temperature high-pressure cracking processes. These results, intended to increase the general knowledge of the industry, supplied the clue that led to a successful solution of the cracking problem. In spite of the abundant examples of research that paid off, however, the report finds that the majority of trade groups find it difficult to finance all the research and development that the research director or research committees believe necessary. The group that surveyed the research being done by professional associations and societies found that almost unanimously society officials feel that additional research by their organizations is desirable and necessary; the major problem is the procurement of funds to support adequate research programs.

These findings are of particular interest to the author since, as director of the National Science Foundation, difficulty has been experienced in convincing the members of Congress of the need for funds to support our own basic research effort at what we feel to be an adequate level. If these groups, which by their very nature are research

minded, have difficulty in obtaining funds to support research at the level they deem necessary, it would appear that a large amount of education remains to be done as to the importance of research to the national welfare.

Economic Implications of Research. Perhaps one reason why it is difficult to obtain adequate support for research is the absence of valid quantitative data as to the returns from research investment. The Battelle report suggests that as a rough measure of the value of all research and development in the United States, the net increase in gross national product from 1900 to 1953 could be cited. In one sense, such a measure can be applied, for much of our present enormous productivity stems directly from advances in science and technology.

Using some very rough approximations, Dr. Raymond Ewell of the Foundation staff has made a preliminary attempt to estimate economic returns from research a little more specifically. According to his rough estimates, research and development conducted during the preceding 25-year period contributed something between $40 billion and $80 billion to the gross national product of $365 billion in 1953. Comparing returns from research with costs, he estimates that during the same period, 1928 to 1953, research and development expenditures in the United States totaled about $30 billion, giving a median cost of about $1.5 billion per year. Comparing $1.5 billion cost with $40 billion return, we have an indicated return of 25 to 1.

Dr. Ewell points out that since we are discussing returns from research performed over a 25-year period, these returns should be thought of as 25-year returns on research investment, and the figure 25 to 1 represents a very high return compared with other areas of investment. The question naturally occurs as to whether we should be investing more of the national income or of the national effort in research and development.

The economic implications of research have been thus far relatively unexplored and much information on the subject is needed. Our studies in this field are still in the planning stage but we hope to explore such questions as: the contribution of research and development to gross national product; the economic values of improved health; the basic-research background of technological developments; economic by-products of military research; and other provocative questions.

OTHER STUDIES

Although the survey as a whole is expected to yield many quantitative data, we are also keenly aware of the problems of a subjective nature that cannot be measured in terms of either men or money. The academic community, for example, is concerned about the growing impact of Federal funds, particularly from research and development grants and contracts, upon the normal teaching and research functions of the colleges and universities. About a year ago the National Science Board appointed a university-government relationships committee, under the chairmanship of Dr. Chester Barnard, to inquire into this whole question. Through a series of interviews with college and university officials around the country, this committee is studying important policy questions involved in government-university relations in science. Foundation staff members are gathering information on the needs and objectives of the Federal agencies which have led them to support research and development at educational institutions. This study, together with the survey of research at nonprofit institutions mentioned earlier, will furnish the committee useful basic information. When the committee's work has been completed we shall undoubtedly have a much clearer picture of the complex new relationship between government and universities that developed out of the needs of World War II and the postwar period.

The whole question of scientific manpower looms large on the horizon. What is the real situation with respect to demand? What can we anticipate in the way of supply in the foreseeable future? What are the long-range prospects with respect to supply and demand?

The studies that have been described are expected to supply some of the answers; and our programs, particularly our fellowship and education in the sciences programs, are designed to help meet the need.

As mentioned previously, a preliminary draft has been made available by the Bureau of Labor Statistics of a report on "Shortages of Scientific and Engineering Personnel in Industrial Research." The report, the first to result from the survey of industrial research, is based upon the personal interviews with officials of about 200 large companies. Together, these companies employ a substantial proportion of all scientists and engineers engaged in industrial research. At least half of the companies interviewed reported shortages of research scientists and engineers, and a substantial part of that half—possibly two thirds—reported major shortages. Incidentally, companies reporting shortages were all in essential industries.

All companies agreed on the need for better-qualified, more highly trained scientists and engineers. A sizable number of firms said they had been forced to curtail projected increases in their research and development programs because of the lack of qualified personnel.

A measure that will add greatly to our knowledge of supply is the registration of scientists and engineers being conducted by the National Register of Scientific and Technical Personnel. Working closely with the professional societies, the Register is well along in the work of acquiring accurate current data on the numbers and location of scientists and engineers. These records are being maintained by the societies on a decentralized basis, but the procedure is so organized that the entire operation could be placed on a centralized basis in case of emergency.

The Foundation recently contracted with Columbia University for a study entitled "Estimating the Supply of Technical and Professional Manpower as of 1965." Other studies relating to supply include a study by the University of Minnesota of "Loss of Talent Through Educational Drop-out." The study consists of a follow-up of a group of talented high school students who did not attend college, and an attempt to determine the reasons for nonattendance. The National Research Council is also continuing its annual "Studies on Doctoral Degrees in Science."

Demand is much harder to assess than supply. The Foundation has a contract with the National Bureau of Economic Research for "A Technical Study of Methods for Determining Demand and Supply of Specialized Personnel." In addition to current needs, the whole question of demand is complicated by the unpredictable future. Let us assume, for example, that automation becomes an established reality. What will be the demands for specialized personnel? A recent article[1] states:

"Automation requires trained and educated people in unprecedented numbers. The quantitative need alone will be so great... that the 8 or 10,000,000 college students we can expect 15 years hence will be barely sufficient. One large manufacturing company (now employing 150,000) figures that it will need 7,000 college graduates a year, once it is automated, just to keep going; today it hires 300 annually.

"But the need is above all qualitative—for better educated people. The 'trained barbarian,' the man who has acquired high gadgeteering skill, will not do. Even in routine jobs, automation will require ability to think, a trained imagination, and good judgment, plus some skill in logical methods, some mathematical understanding, and some ability well above the elementary level to read and write—in a word, the normal equipment of educated people."

Estimating the scientific manpower needs of the present and attempting to gauge the situation a generation hence are only a few of the larger issues that the National Science Foundation must consider as we discharge our important function of developing and encouraging the pursuit of a national science policy. It is not our function to make such policy, but rather to provide the fundamental data and to take the lead in its formulation and development. Industry, the scientific community, the academic community, business, and government all have a share in determining what national science policy should be. In an address before the American Institute of Chemical Engineers,[2] J. E. Hobson, director of the Stanford Research Institute, stated that "Industry's role in developing a national science policy must also reflect new conceptions and a reorientation of thinking about the critical nature of fundamental research in society." After mentioning industry's support of education and basic research, he then goes on to say, "...industry is ultimately the chief consumer of basic research; it is critically dependent upon an ever-replenished supply of fundamental scientific knowledge; present mechanisms are not geared to fill the need; a new concept, a new approach, new national science policies must be conceived."

THE GENERAL REPORT

THROUGH the fact-gathering activities described, the Foundation is attempting to construct a picture of the $4 billion research and development activity in the United States. The survey covers the scientific activities of the Federal Government, research by nonprofit institutions, research by industry, and many types of information needed with reference to the scientific manpower problem. It is hoped that the results of the survey will, among other things, contribute to a better understanding of what the role of the Federal Government in support of research should be.

It should not be inferred that the National Science Foundation's contribution to the formulation of national science policy will be a large mass of undigested data. Rather, it is planned to reduce the findings to a series of general reports that should be both readable and useful, and, under the direction of James M. Mitchell, assistant to the director of the Foundation, a special committee has begun the preparation of the general report. It should be emphasized also that the whole task of establishing a sound body of data regarding the national effort in research and development would have been quite impossible without the co-operation and help of many individuals and organizations. We are selfconsciously aware that we have contributed to the never-ending stream of forms and questionnaires that flows out of Washington. Nevertheless, the painstaking care with which so many of these questionnaires have been completed and returned, the readiness to grant requests for interviews, lead us to believe that there is interest in knowing more about our national research and development effort. We hope that our ability to present these data, properly established in a larger framework, will justify the survey and its usefulness.

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"Stethoscope" at Work

An ultrasonic device to inspect a massive forging from which a turbine-generator shaft will be machined is being used by Westinghouse Electric Corporation. Sound waves at the rate of 2,250,000 cycles per second are set up in the machine, and if the slightest flaw is detected an "echo" will indicate its exact location. Formerly, the only way of determining the quality was by boring a hole through the center of the forging. With ultrasonics, the quality can be determined. With this method, it is possible to detect fine holes, slag, inclusions, and other imperfections

An Automatic Field Plotter

R. GELFAND
ASSOCIATE MEMBER AIEE

B. J. SHINN
STUDENT MEMBER AIEE

F. B. TUTEUR
ASSOCIATE MEMBER AIEE

THE SOLUTION to a large number of physical problems involving such topics as heat transfer, fluid flow, electric or magnetic fields, etc., may often be found most easily by setting up the required boundaries in an electrolytic tank. This is essentially an analogue method, and the solution consists in finding the equipotential lines and tracing them on a piece of paper.

The speed and accuracy of the process of locating the equipotential lines in the tank is increased materially by using a servomechanism to perform this task. In its simplest form, this consists of drive mechanism capable of moving a probe in a rectangular co-ordinate system across the surface of the tank, the probe moving along the x axis at a constant speed. The voltage picked off by the probe is compared to a reference voltage, and the amplified difference is applied to the y-axis drive motor in such a way that the resulting probe motion will reduce the difference to zero. The location of the probe may be monitored by potentiometers so that a standard x-y recorder may be used to record the field pattern.

A serious disadvantage of this simple system is that the sweep speed along the equipotential lines is not a constant and that closed curves and double-valued curves cannot be tracked at all. Both of these limitations may be overcome if the co-ordinate system along which the probes move is rotated with respect to the tank so that the x, or sweep, axis is always parallel to a line drawn through the probe and tangent to the equipotential line being tracked. In practice the physical rotation of the co-ordinate axes is not practical, but the same result may be obtained by passing the constant sweep voltage and the error voltage through two resolvers whose angle input is the desired angle between the tangent to the equipotential line and the original x axis. If the resolvers are properly connected, the probe may be made to sweep at any angle θ with respect to the x axis. Under these circumstances the correction will be at right angles to the sweep.

The proper input angle to the resolvers is best obtained by using an axuiliary probe located in the close vicinity of the main probe. The voltage between the main and auxiliary probes is zero only when both probes are located on the same equipotential line. Hence a servomechanism may be arranged which applies the amplified voltage picked up by the two probes to a motor which will automatically rotate them to lie on the same equipotential line. A line drawn through both probes is then approximately the desired sweep direction. All that is finally required is a third servomechanism to follow up the probe position and rotate the resolvers in accordance with it. A block diagram of the complete system is shown in Fig. 1.

The loop gain of all the servos except the resolver follow-up is directly proportional to the potential gradient existing in the tank around the probes. Therefore, where the equipotential lines come close together the system tends to become unstable, whereas a wide spacing of the lines tends to result in decreased accuracy. This difficulty may be overcome by using a third probe, not shown, located near the two probes described previously and on a line perpendicular to a line drawn through the original two. The voltage picked up by this probe is approximately proportional to the potential gradient and may be applied as a bias to a variable-gain tube in the amplifiers to compensate for the gain variations caused by changes of potential gradient.

In order that the field pattern of the model in the electrolytic tank be as similar as possible to the one under study, it is necessary to reduce the edge effects caused by the less-than-infinite extent of the tank. A very satisfactory method for doing this had been described in the literature[1] and consists essentially of two conducting circular surfaces placed back to back, separated by an insulator, and joined at the circumference. This configuration may be shown to be equivalent ideally to an infinite conducting sheet with the center of the lower sheet taken to represent the point at infinity.

Digest of paper 55-104, "An Automatic Field Plotter," recommended by the AIEE Committee on Basic Sciences and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in AIEE *Communication and Electronics*, March 1955, pp. 73–8.

R. Gelfand, is with the University of Pennsylvania, Philadelphia, Pa.; **B. J. Shinn** is with the General Electric Company, Schenectady, N. Y.; and **F. B. Tuteur** is with Yale University, New Haven, Conn.

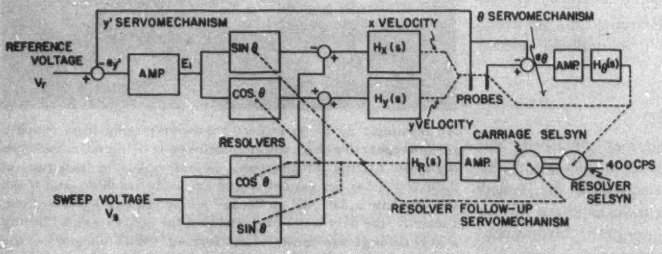

Fig. 1. System block diagram

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Perpendicularly Superposed Magnetic Fields

ROBERT HEARTZ
ASSOCIATE MEMBER AIEE

H. O. BUELTEMAN, JR.

THE CHARACTERISTICS of a ferromagnetic reactor as a function of two perpendicularly superimposed magnetic fields were discussed in an article by Beck and Kelly[1] in 1948. The core and coil configuration shown in Fig. 1 illustrates one practical method for superposing two perpendicular magnetic fields. The core is a hollow toroid of ferrite material which encloses an annular coil, and which is wound toroidally by a second coil. This core and coil configuration will be referred to as a cross-field reactor.

The operation of the cross-field reactor is illustrated by the hysteresis loops of Fig. 2. The largest loop is the normal 60-cycles-per-second hysteresis loop as seen by the toroidal coil. The smaller loops are those seen by the toroidal coil when a large direct current flows in the annular coil. If the direct current in the annular coil is large enough to saturate the entire core volume, then the core characteristics as seen by the toroidal winding will be similar to an air core. The smallest hysteresis loop of Fig. 2 continues to show appreciable area and slope because of the relatively large alternating current used to record the loop.

The cross-field reactor can be used for a low level d-c converter or modulator, by exciting the annular winding with an alternating current which is large enough to saturate the entire core volume. As the toroidal winding is magnetically perpendicular to the a-c winding, the voltage induced in this winding will be theoretically zero. However, the core permeability, as seen by the toroidal winding, will be varying from maximum to air-core value as a-c excitation varies from zero to saturation. If a small d-c signal is applied to the toroidal winding, the flux generated

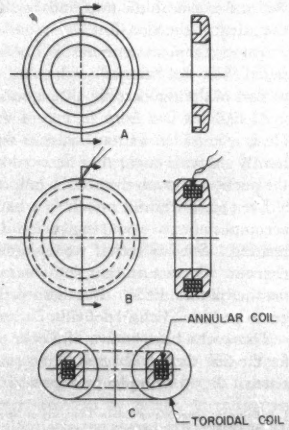

Fig. 1. Fabrication of a cross-field reactor

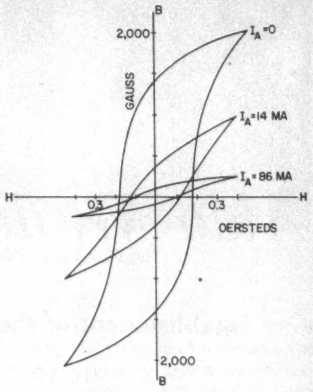

Fig. 2. Toroidal hysteresis loops as a function of d-c annular current

in the toroidal direction will vary with the core permeability. This varying flux will induce an alternating voltage in the toroidal winding whose magnitude is proportional to the d-c signal current and whose frequency is twice that of the annular-coil excitation frequency. Two cross-field reactors, excited by a half-wave supply, can be connected so that even harmonics in the output voltage are canceled. With this circuit, a large voltage gain is possible and the a-c output is independent of the signal source impedance. The threshold signal of the second harmonic-type modulator is approximately 10^{-14} watt (0.01 microampere) when operated into a second-harmonic selective system. When operated as a fundamental-frequency modulator, the threshold is approximately 10^{-12} watt. This increase in threshold can be expected because noise pickup is predominantly the same frequency as the output signal.

The cross-field reactor also can be used as a variable inductance because the permeability of the toroidal coil is a function of the d-c annular current. By proper tuning, the unit can be used as a frequency multiplier or divider. Two cross-field reactors can be connected so that the output is proportional to the product of two d-c signals. A cylindrical-core cross-field reactor offers some very attractive features as a magnetometer or as a permanent-magnet biased-current reference source.

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Robert Heartz and H. O. Buelteman, Jr., are with Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

the LAMME MEDAL

Aldo M. deBellis—1954 Medalist

Establishment of the Medal

S. B. CRARY
FELLOW AIEE

BENJAMIN Garver Lamme, a graduate mechanical engineer from Ohio State, had a lifetime association with the Westinghouse Electric Corporation as a design and developmental engineer, and later as their chief engineer.

Lamme was fundamentally an engineer and a teacher whose work was his life. He substituted, whenever he could, calculations for cut-and-try methods. True to his concepts of the engineering profession, he realized the value and need of recognizing outstanding technical achievement. He bequested to the AIEE the establishment of an award for members of the Institute who have "shown meritorious achievement in the development of electrical apparatus and machinery." By the grant of such a distinguished engineer, there was immediately established an award of high prestige and character. In further keeping with Mr. Lamme's consistent recognition of the technical aspects of engineering, this medal is inscribed with the quotation, "The Engineer Views Hopefully the Hitherto Unattainable." This inscription is a symbol of Mr. Lamme's optimism and faith in the creativeness of the engineer.

The meritorious achievement required by Mr. Lamme is taken to mean that which results in the production of substantially improved electric machinery. Any work which meets this requirement is admissible whether it be the development of (*a*) theory, (*b*) characteristics of the materials employed, (*c*) over-all design, or (*d*) other ways which result in substantial improvement in electric apparatus or machinery. The words "electric apparatus or machinery" indicate discrete and self-contained devices. They do not include transmission and distribution systems as a whole, but rather apparatus and machinery which is used in making such systems.

The 1954 medal is the 27th to be awarded to a member of the Institute. The achievements of the recipients include improvement in rotating machinery, lightning arresters, transformers, circuit breakers, bus structures, instruments, welding, rectifiers, television, and communication. Today, another name is added to the very distinguished list of outstanding engineers who attest to the clear and constant ideals of Benjamin Garver Lamme.

Presentation and acceptance addresses given at the Lamme Medal ceremony held during the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955.

S. B. Crary, General Electric Company, Schenectady, N. Y., is chairman of the AIEE Lamme Medal Committee.

Career of the Medalist

J. F. FAIRMAN
FELLOW AIEE

IT IS with personal, professional, and corporate pride that I approach the traditional assignment of delineating the career of the medalist.

The assignment sent me to my favorite dictionary. I found the word "career" defined as a "a swift course, such as that of the sun or a star through the heavens."

Al deBellis was born in one of the romance countries. He is a musician and an artist as well as an engineer. I hardly think, though, that he would forgive me if I chose the poetic approach the book definition seems to suggest.

Even so, to restrict myself to a bare recital of the man's accomplishments would make for dull listening and dry reading. Such a recital would omit the most important element. I am sure that you would prefer to know what manner of man he is. In other words, how did Al deBellis get to be Aldo Michael deBellis, Lamme Medalist.

Those who have known him over the years, or meet him for the first time, will agree that socially he is as gentle as a kitten. But to complete the portrait, I would remind you

J. F. Fairman, Consolidated Edison Company of New York, Inc., New York, N. Y., is a past president of the Institute, 1949–50.

A. C. Monteith presents the Lamme Medal to Mr. deBellis

that in defense of his principles, and of his conclusions patiently formulated, he can be as formidable as a lion—let me hasten to add, with all the dignity and none of the roar.

Al deBellis is one of those fortunate men who knows what he wants. I do not mean that in terms of narrow ambition. He wants good music to listen to, a garden to work in, an occasional palm tree to sit under, old friends with whom to relax, and, at the top of the list, he wants and is determined to meet squarely his responsibility as an engineer to the world he lives in. The success he has had in meeting this challenge has been a substantial dividend to Consolidated Edison and to the electrical industry.

Al deBellis was born in Genoa, Italy. He went to school first at Perugia and later in Rome at the Royal Technical Institute and the Royal University where he earned his bachelor of science degree.

He came to America soon after, a pattern first established by another famous Genoese some years earlier. In New York, deBellis enrolled at Brooklyn Polytechnic Institute and got a job as draftsman with The New York Edison Company. The job paid $12 a week, incidentally, a pretty good bargain from the company point of view. The stipend improved with time but evidently not quite rapidly enough because in 1916 deBellis quit. This flight from New York Edison took him to New York's Interborough Rapid Transit, to Stone and Webster in Boston, Mass., and off the war-bound port of Trieste where he listened for U-boats over the primitive detecting devices of one of the U. S. Navy's 110-foot submarine chasers.

Al deBellis came back to New York Edison in 1920 and by 1925 he was assistant design engineer, just two job spots away from the distinguished Philip Torchio, then chief electrical engineer.

The years following World War I brought rapid expansion to New York City with the result that New York Edison, until then a direct current stalwart, began to cope with the zooming electric demand by greatly extending its operations into the alternating current field. DeBellis, probably not by accident, was on the growing a-c side of the house, up to the limits of his sliderule with the design of new a-c substations and a-c facilities in generating stations.

He had a fairly justified reputation with Edison drafting personnel of being a hard man to please, but this was no petty supervisor-employee crochet on his part. Al deBellis was, and is, a hard man to please in the important sense of the word. He wants perfection and does not mind a little trouble to get it.

An a-c substation being built in the Bronx was a historic case in point. He felt American manufacturers were falling behind the art. Substations built with their equipment were dramatic, perhaps, in their array of open and hazardous switchgear. DeBellis sent to the Reyrolle Company of England for metal-clad switchgear, which he considered the most advanced design at that time. This decision pressured American makers to improve their product and started Aldo M. deBellis on his way to the Lamme Medal.

Trouble, real trouble, again focused his attention on metal-clad equipment. A serious fire at Hell Gate in 1935 was featured by a baffling chain reaction as one bus section after another burned out. Investigation disclosed that the trouble was spread from compartment to compartment by the dispersion by the arcs of copper dust which settled on the insulators.

At the time, the company which had become Consolidated Edison, was facing up to the modernization of one

Aldo M. deBellis of the Consolidated Edison Company of New York has been awarded the 1954 Lamme Medal "for his contributions to the design and development of power station equipment, especially air-insulated phase-isolated metal-clad high-voltage bus structures and disconnecting switches."

of its two Waterside generating stations. Elbow room at Waterside was tight and deBellis first sought to meet the situation by adapting the metal-clad idea to a rectangular bus structure. He followed through, however, in typical deBellis fashion. What started as a few lines of verse became an epic poem. The end result was a complete system with a round bus, disconnect switches, and air circuit breakers, all metal-clad; safe, compact, vaporproof, and economical.

This was for 13.8-kv circuits. Since then, Consolidated Edison, and of course, other companies, have applied the metal-clad design to busses and switchgear handling higher voltages. At this time Consolidated Edison is installing a new 138-kv submarine tie across the East River. Due again to deBellis, the switchgear and bus will be metal-clad.

The peculiar geography that is New York was behind the drive of deBellis for low-noise-level transformers. Another important factor was his faculty of putting his finger on where the company was needlessly, or fruitlessly, spending money.

Consolidated Edison often envies other electrical utilities who can build their power plants on some remote river bank on the outskirts of the community they serve or set their substations on a lonely moor. Edison plants, with only one minor exception, are built square in the city itself, right across the street from the apartments of disapproving customers. They love the company's electricity but cannot help wishing it were made somewhere else. And there is no such place.

Moreover, throughout the network areas the citizens were far from enthusiastic about the constant hum from transformer vaults beneath their sidewalks. Transformer noise, therefore, was perhaps a greater problem than for most companies. Many ways were tried to offset it, with special walls, screens, baffles, and the rest.

Al deBellis was conscious that these sound-control devices cost money and usually did not do a job in return. He thought it wiser that the money be put into the transformer rather than appendages thereto and managed to convince the manufacturers. One of the direct dividends, of course, is the present practicality of outdoor substations in residential areas. Consolidated Edison still marvels that the day has come when it can operate such installations in suburban settings and be considered among the community's most desirable neighbors.

In recent years, however, the mention of deBellis at Consolidated Edison does not bring up the picture of metal-clad switchgear and cat-quiet transformers. He is "deBellis, that 69-kv man." It was he who put the company in the business of 69-kv bulk underground transmission to local load centers.

Again the combination of New York geography and operating necessity brought out the deBellis qualities. You may have seen recent articles about how New York is slipping down the drain. You might possibly believe them unless you tried to rent commercial space or were responsible for the city's electric supply. New York electric loads, particularly in Manhattan, have increased greatly. To meet them Consolidated Edison has had to add nearly 500,000 kw of capacity to its East River station at the foot of East 14th Street, the one station which was both reasonably close to the Manhattan load center and had room to install new turbogenerators.

Putting in the machines was one thing; getting the new power out of the station was another because all of it had to be delivered beneath city streets. Someone has said, with reason, that in most places in Manhattan the only safe method of excavation is with a tablespoon. New York utilities—water, gas, telephone, telegraph, mail, and steam, as well as electricity—have been putting installations under Manhattan's streets since the days of Aaron Burr. Aaron, incidentally, started the whole business with his network of hollow cypress logs for water supply and some of them are still in position.

Because of the extent of the company's underground system—it has no overhead whatever in Manhattan and not too much in the other boroughs—its distribution costs are about triple those of power generation. Along with the subsurface congestion problem, the money angle worried deBellis who was sure there was a better way.

The better way of Al deBellis was to employ pipe-type oil-filled 3-conductor cables to take the power out of East River at 69,000 volts, fanning it out to area substations of 200-megawatt capacity. In a current job, the installation of which now scars some of Manhattan's principal traffic arteries, a new touch has been added; 69-kv feeders deliver direct to the network transformers at one of midtown's new skyscrapers.

Al deBellis will retire from the company's active service within the year and he plans to transfer his personal residence to Florida. In the larger sense, however, he will always be in residence at Consolidated Edison. The mark of his talent will endure in the modern design of the company's electric stations and in the complexities of the vast network beneath the busy streets. A well-trained cadre of engineers who grew to professional maturity under his leadership will continue to be influenced by the force of his example and the validity of his principles.

Aldo M. deBellis richly deserves his industry's acclaim. Consolidated Edison is proud indeed that he has been chosen to receive the Lamme Medal for some of his many contributions to the art. As individuals and as engineers, we of Consolidated Edison have been honored to be his associates and to call him friend.

Opportunity and Co-operation in the Electrical Industry

A. M. DEBELLIS
FELLOW AIEE

IT IS WITH A MIXED FEELING of pride and humility that I accept the Lamme Medal.

In thanking the Institute for the honor bestowed upon me, I like to think that this presentation is a symbolic recognition

A. M. deBellis is with the Consolidated Edison Company of New York, Inc., New York, N. Y.

of the many contributions made by so many engineers in the electric power industry.

I am also mindful of the fact that the engineering work which this presentation recognizes has been possible only because of two sets of circumstances. One has been my association for so many years with a company which has provided both opportunity and support. The other has been co-operation with the manufacturers.

The story of the evolution of the Consolidated Edison system during the past 40-odd years makes interesting reading. It is not only typical of the remarkable progress in the development of the electric arts which has taken place in these United States, but it is a living example of how opportunities for service and achievement, often-time born out of necessity, have been fostered by forward-looking company policies.

As I look back over the years one of my most thrilling experiences was my introduction, early in 1913, to the Waterside stations of the New York Edison. These two stations, side by side, were then the largest concentration of power in existence, and stood as a monument to American superiority in the field of electrical utilities.

They had a combined capacity of 229 megawatts (mw) and, through rotary converter substations, 27 of them, located at the load centers, they supplied the bulk of the energy used on the Consolidated system whose distribution was then primarily direct current.

At that time the Consolidated system consisted of three companies, the New York Edison, the United Electric Light and Power, and the New York and Queens Electric Light and Power. Towards the end of that year the United Company which distributed exclusively 60-cycle alternating current in the Borough of Manhattan and which had been receiving bulk power from the Waterside stations, placed in operation its Sherman Creek station with a capacity of 45 mw, the last word in central-station engineering and design.

This addition brought the combined generating capacity of all the electrical companies supplying the five boroughs of New York and Westchester, which is the entire area presently served by Consolidated Edison, to a grand total of 397 mw. Of this amount, barely 67 mw were 60 cycle while 10 mw were still d-c generation.

By way of contrast, Consolidated Edison today has an installed generating capacity of 3,736 mw of which 3,300 mw are at 60 cycles. A new turbogenerator unit, just ordered, will have a maximum capability greater than the combined capacity of all the units which supplied all of the boroughs in New York and Westchester early in 1913 when I was admiring the mighty Waterside stations.

Cold statistical figures, although expressive as they are of the swift course of progress of Consolidated Edison and its predecessor companies during this relatively brief space of time, are, however, utterly inadequate for us to visualize the magnitude of the task of keeping abreast of the requirements of a fast growing and ever-changing city, and of the exceptional opportunities available for new ideas which would bring forth better, simpler, and more economical ways of doing things.

During this 1913–55 period, we have seen the d-c system of distribution reach a high degree of perfection and grow in importance, but we have also watched its decline.

We have witnessed the birth and growth to full maturity of a new art, a superseding art, the low-tension a-c network which has been and still is a rich field of opportunities for pioneer engineering, design, and operation.

We have watched the building of great generating stations, Hell Gate, Hudson Avenue, East River, and Astoria; each of them with an individual personality indicating freedom of thought and of opportunities for new developments, be they in the field of equipment and station design, or in system planning or in operating policies.

And as these new stations were developed and added to the system, we have also seen the pioneering and growth of a network of underground high-voltage transmission lines.

Today we are on the threshold of new experiences. The nuclear generating station at Indian Point has appeared on the horizon, a new challenge, a new harbinger of still greater opportunities to come. And as New York keeps growing and changing, new distribution and transmission problems will arise with many promising possibilities for the development of new and better ideas.

In this brief outline of some of the more recent milestones in the career of Consolidated Edison, it is quite appropriate, I believe, that credit be given where credit is due. Credit goes in large measure to a company which has encouraged a dynamic type of philosophy and to a large group of engineers and other people in various departments of the company who have devoted themselves to the realization of an ideal, the ideal of carrying on in our vital industry in the true Edison tradition.

There is another group of people, however, the manufacturers, to whom I wish to give full credit for having contributed to so many of the developments which are part of Consolidated Edison history.

One of my most enjoyable activities over many years has been the close association with a large group of engineers from various manufacturers and our working together in an atmosphere of mutual trust and respect. I can bear witness to the many times when the germ of an idea has been eagerly accepted by them and painstakingly nursed into a new effective tool. Oftentimes this kind of co-operation has been given with the full realization that their work would probably receive but scant recognition.

I wish it were possible for me to mention here the many engineers within the various manufacturer organizations, who have made outstanding contributions. I feel that I would be remiss, however, were I not to mention at least a few men among those whom I know from personal contact to have contributed much to some of the more recent developments because of their foresight, driving energy, and superior technical skill. Such men, for instance, as Ben Kerr and Harold Rudd of Railway and Industrial—I-T-E, and Bob Bennett and Bill Ginn of General Electric, and Sam Griscom, Maurice Hobbs, and Benny Baker of Westinghouse.

And now, as I am about to retire to the sidelines, I want to express my thanks for having had the privilege of working in an industry filled with opportunities, intensely human and rich in friendships.

Calculating Servo Transient Response

D. V. STALLARD
ASSOCIATE MEMBER AIEE

THE methods of calculating the closed-loop frequency response of a linear control system are well known and straightforward. To calculate the transient response to a step input, which in some cases may be more important, is more difficult. There is need for a simple fast method of calculating the step transient response (preferably from the frequency response) for analytic purposes, and also for gaining insight into design for a specified step response.

A simple method of calculating the step transient response involves the formation of a convergent sine series directly from the closed-loop frequency response. Using the method of Tustin,[1] one may replace the step input x_r and the transient response x_c with an equivalent square-wave input x_r' and a periodic response x_c', providing that the response x_c comes to rest in the first quarter-period of x_r'. The square-wave input x_r' has Fourier sine-wave components at frequencies ω_1, $3\omega_1$, $5\omega_1$, $7\omega_1$, $9\omega_1$, etc. Hence, by superposition, the periodic response x_c' is the sum of the responses to each sine-wave component taken separately, and can be expressed as a convergent sine series; each term of the series contains the magnitude $|W_n|$ and the phase angle $\underline{/W_n}$ of the closed-loop frequency response. This series for x_c' can be simplified into one which involves only the real part $Re(W_n)$ of the frequency response, and is expressed as

$$x_c' = a\frac{4}{\pi}\sum_{n=1,3}^{\infty}\frac{Re(W_n)\sin(n\omega_1 t)}{n} \qquad (1)$$

where n is the number of the harmonic frequency, and a is the amplitude of the step input x_r.

The usefulness of Tustin's method is increased by a new means of determining a good choice of ω_1 and testing the convergence of the resulting series. The "build-up time"[2] t_b for the first overshoot can be estimated as π/ω_c, ω_c being the "cutoff" frequency at which the closed-loop phase angle is $-90°$. It may be assumed that the transient comes to rest before time $4.5t_b$, which is set equal to the quarter-period of the square-wave x_r'. These assumptions make the fundamental frequency ω_1 of the square-wave equal to $\omega_c/9$. The convergence and accuracy of the sine series is easily checked at the end of the first quarter period by substituting $90°$ for $\omega_1 t$ into equation 1, which necessarily must equal a.

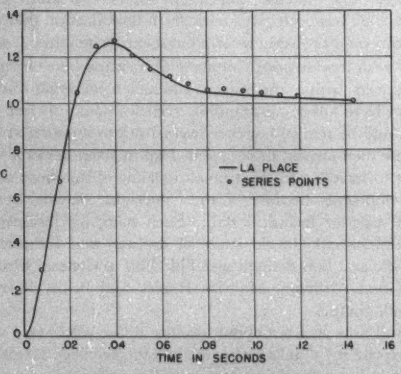

Fig. 1. Step response of instrument servo

The example chosen to illustrate the method is the transient response of an actual instrument servomechanism compensated by a mechanical damper; the open-loop transfer function is

$$\frac{X_c}{X_e} = \frac{1320(0.064s+1)}{s^2(0.00744s+1)} \qquad (2)$$

From a plot on the gain-phase plane, eight coefficients were derived for the series, and the response was calculated at 5-degree intervals. The response x_c' is plotted in Fig. 1, together with the exact response x_c calculated by the conventional Laplace transform method.[3] Most of the points agree within 2 per cent.

Integration or differentiation of the time series for the step response x_r yields the ramp response or impulse response respectively. In the limiting case, the series for the impulse response becomes an exact integral.

The real part $Re(W_n)$ is perhaps the most useful single parameter of the closed-loop frequency response for analyzing transient responses.

It is apparent that the step response calculated by the series is sufficiently accurate for engineering purposes. Furthermore, the coefficients of the series are quickly found from the open-loop frequency response, which is usually plotted on the gain-phase plane for design purposes anyway. After the series has been checked for convergence and accuracy, it can be assigned to engineering assistants as routine numerical calculation. Each computation yields a point on the step response plot. There is no need for special curve fitting or difficult solutions of poles, as in other methods. The series method is direct, simple, and accurate, and is a natural supplement to frequency-response analysis.

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D. V. Stallard is with Massachusetts Institute of Technology, Cambridge, Mass.

Color-Video Transmission Over Intercity Television Networks

by G. J. HARMS

Transmission of color video presents a number of problems that were not encountered in monochrome transmission. The Bell System is attempting to improve transmission of chrominance information so that it is free of any phase and amplitude distortion, as well as reflections and external interfering energy.

REGULAR commercial broadcasting of color television in accordance with the specifications formulated by the National Television Systems Committee (NTSC) is now more or less commonplace. During the past years, the Bell System has been constantly striving to improve color transmission and at the same time handle a considerable increase in video facilities to be used for both monochrome and color transmission. This article describes some of the transmission difficulties encountered with color video and the means used to overcome them. However, first, some general background information will be given, as well as a brief description of the video signal.

VIDEO NETWORK FACILITIES

BELL SYSTEM intercity television service was inaugurated on May 1, 1948, via one radio channel in each direction between New York, N. Y., and Boston, Mass., and one coaxial cable channel in each direction between New York and Washington, D. C. These facilities made a total of 900 channel miles. Facility growth since that time has been at a very high rate, and at the end of 1954 more than 69,000 miles of television intercity channels were in service. Of this total, about 20,000 miles are on coaxial cable and 49,000 miles on radio relay. Conversion of those facilities to handle color video required most of the year 1954.

NATURE OF THE SIGNALS

THE NTSC color-video signal may be considered as made up of four basic forms of information transmitted in proper sequence, namely: (1) synchronization information to establish a raster for presenting the picture material in proper position in time and space; (2) picture luminance information; (3) picture chroma information on a subcarrier; and (4) synchronization information for chroma picture material.

Items 1 and 2 are used for both monochrome and color-video transmission whereas items 3 and 4 are used only in color-video signals. The chrominance information consists of two components which are transmitted by a subcarrier of approximately 3.6 mc. One component (the *I* signal) is modulated by the subcarrier directly and the other component (the *Q* signal) is modulated by the subcarrier in quadrature. This chroma information is transmitted simultaneously with the luminance information as shown in Fig. 1. The chroma-synchronization information is transmitted by a burst of subcarrier at back-porch level immediately following each horizontal synchronizing pulse. Since this subcarrier burst determines the relative phase of the subcarrier oscillator in each video receiver with respect to the chroma material at picture level, it is imperative that this phase relation be closely maintained during transmission. Also, since the chroma material is transmitted at frequencies in the upper end of the video-signal spectrum, more exacting requirements are made necessary than has been the case for monochrome transmission.

BASIC TRANSMISSION REQUIREMENTS

IN GENERAL, a transmission medium which will transmit desired frequencies without phase and amplitude distortion and is free of reflections and external interfering energy will be satisfactory for video transmission. From a practical standpoint the Bell System facilities are maintained as near to these conditions as feasible. The major portion of the transmitted energy of the monochrome signal is in the lower end of the video-frequency spectrum and this fact has

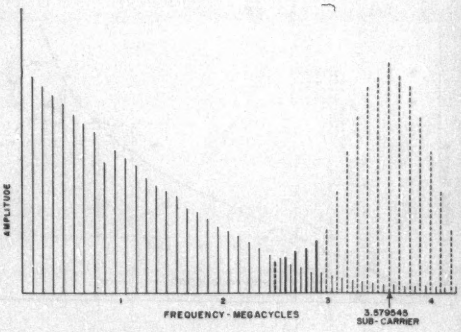

Fig. 1. Color-video spectrum:

– – – Represents harmonics of 15,750~ monochrome line rate

═══ Represent I signal on subcarrier

——— Also represents Q signal on quadrature subcarrier, which in each signal is the double side-band portion

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G. J. Harms is with the American Telephone and Telegraph Company, Cincinnati, Ohio.

centered the transmission problem about the lower-frequency range, particularly below about 1 mc.

The more common of these troubles are streaking, smearing, and transient images.

COLOR TRANSMISSION REQUIREMENTS

With the transmission of color-video signals, the problems encountered in monochrome transmission still exist and, in addition, other problems are met because of the nature of the color signal. It was pointed out previously that the phase relations between the subcarrier synchronizing burst and the chroma signal must be maintained within close tolerances. This requirement stems from the fact that the color hue in the receiver is determined by the relative phase of the subcarrier components. This type of phase shift between the color burst and the signal subcarrier components is known as differential phase distortion

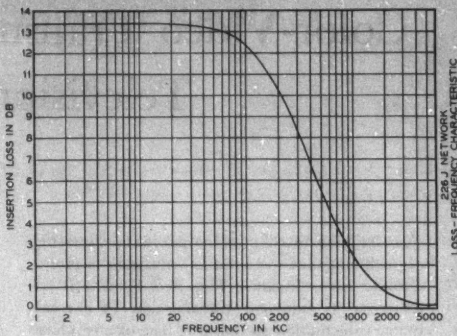


Fig. 4. Pre-emphasis network

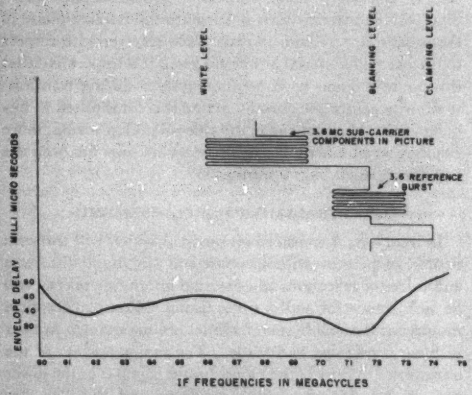


Fig. 2. Differential phase on radio relay

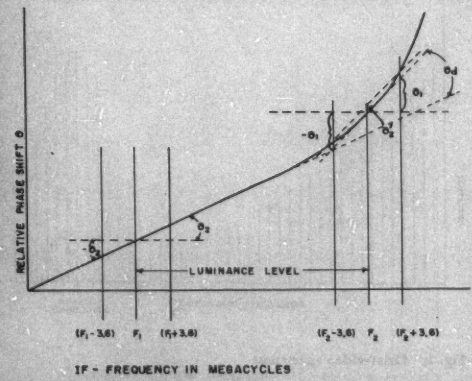


Fig. 3. Phase distortion illustrated:

θ_1—Phase shift in video 3.6-mc signal; θ_2'—Relative phase shift of carrier to side bands which results in amplitude components; θ_d—Differential phase

and is generally a function of the luminance intensity. At present, the differential phase is held to 5° or better.

Fig. 2 illustrates how differential phase and gain can be introduced into a video signal when transmitted over radio-relay facilities. The delay distortion in this figure is illustrative only, and any particular channel may show different characteristics. Also, the delay distortion will, in general (for small values of modulation index), affect the frequency-modulated signal in two ways. It will cause a phase shift of the modulating video signal and any unbalanced phase component relative to the carrier and side bands will result in a component of amplitude modulation, along with a reduction of FM deviation. The last item contributes to differential gain distortion. In the figure the delay distortion is different at the various frequencies and, as a result, the phase distortion about various center frequencies is different. This results in differential phase between the back-porch level and the picture level for various amounts of luminance. As a concrete example, a portion of a video signal to be transmitted over ratio-relay facilities is shown with the synchronous pulse clamped at 74-mc intermediate frequency and the white level at 66 mc. The color burst will deviate from a center frequency of about 72 mc and the subcarrier components in the video signal will deviate from a center frequency of about 68 mc. The delay at these frequencies is different and will result in differential phase at these video levels. Fig. 3 illustrates graphically how phase distortion results in differential phase, and also produces components of amplitude modulation. The solid curve represents phase distortion which might exist in a microwave channel. The dotted line represents an ideal phase characteristic. The broken line which is an extension of the solid curve represents symmetrical phase shift about the center frequency which appears as phase shift in the video signal. The unbalanced phase component designated θ_2' will cause an amplitude-modulated component to appear in the frequency-modulated wave and will also reduce the deviation.

For a small modulation index the deviation will be reduced by a factor $(1-\text{Cos}\ \theta_2')$. This type of distortion will contribute to the differential gain. Likewise, unequal amplitude effects on the upper and lower side bands will re-

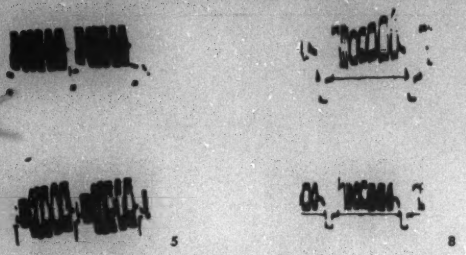


Fig. 5. Multiburst signal above left and the same signal (below left) after pre-emphasis plus 3 db. Fig. 8. Distortion of multiburst signal, showing (above right) typical example of distortion due to amplifier overload, and (below right) typical example of normal multiburst signal

sult in amplitude-modulated components. In the *TD-2* system, a certain amount of limiting action takes place at each repeater and, as a result, the amplitude components of distortion are more or less eliminated from the signal and leave the component θ_1 as being the phase shift after limiting. The delay equalizers used to correct this distortion have a delay characteristic linear with frequency, with a slope of about 0.85 and 1.8 milimicroseconds per megacycle. Both negative- and positive-slope equalizers are available. In general, this phase shift is permitted to accumulate over as many as six to eight repeater sections and is then mopped up. This method allows some variations in phase distortion due to increased path loss, which reduces the effective limiting and permits some of θ_2' of Fig. 3 to appear at the end of the mopped-up section, and temperature changes, which may change the tuning cavities in the amplifiers, will also change θ_1.

It is apparent that if the luminance and synchronous-pulse amplitude are reduced, the subcarrier burst and subcarrier picture components will deviate from frequencies which are much closer together, and phase variations will not be as severe. This has been done by pre-emphasizing the video signal before transmitting it over the radio-relay facilities and restoring the signal at each receiving point. The pre-emphasis with respect to the video frequencies is shown on Fig. 4. It will be noted that the loss at 500 kc is about 6 db higher that at 4 mc, and at 50 kc is about 13 db higher. Because of the high loss to the low frequencies the synchronous pulse has been effectively removed as shown in Fig. 5 which shows a multiburst signal before and after pre-emphasis. For this reason the signal cannot be clamped, and the FM deviation now takes place about the average energy axis of the composite pre-emphasized video signal as shown in Fig. 6. In this figure the rest frequency is 70 mc and the video signal deviates about this frequency.

It will be noted that the center frequencies for the subcarrier burst and picture material are much closer together and, likewise, the amount of differential phase has been reduced. This arrangement will therefore reduce the variations of differential phase, and thus make the system more stable in so far as differential phase is concerned.

Differential phase and gain can also be introduced by nonlinearity in video amplifiers as illustrated in Fig. 7. The differential gain results from a tube characteristic which deviates from a straight line and the differential phase can result from changes in transconductance of tubes particularly when the setup is large. This generally happens only when excessively high levels are sent into the system or trouble exists. Along this same line, Fig. 8 shows the effect of nonlinearity in a video amplifier upon a multiburst signal.

As was pointed out previously, the chroma material is

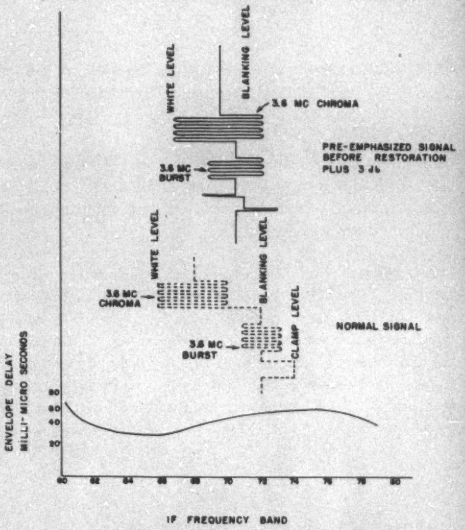


Fig. 6. Pre-emphasis applied to radio-relay facilities

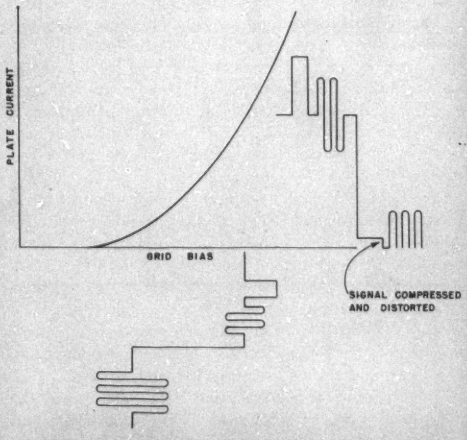


Fig. 7. Differential gain in vacuum-tube circuit due to excessive level into vacuum tube operating on nonlinear portion of curve

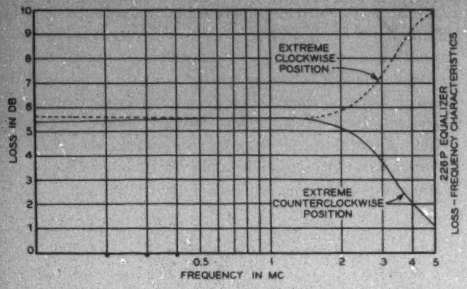


Fig. 9 (above). Attenuation equalizer characteristic for roll off.

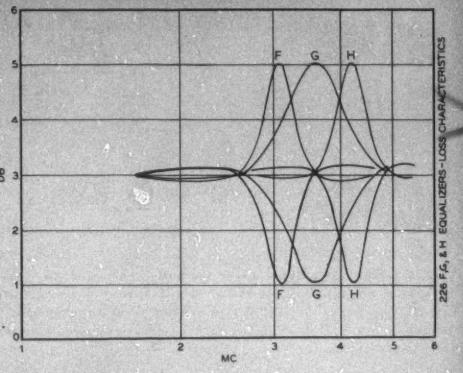


Fig. 10 (right). Attenuation equalizer for color-video circuits

transmitted on a subcarrier using an *I* and *Q* signal modulated with quadrature subcarrier components. This arrangement introduces further requirements regarding phase and amplitude with regard to the side bands of the subcarrier.

Any deviation of these transmission parameters will result in a cross-modulation between the *I* and *Q* signal with resultant color contamination. In order to maintain proper symmetry between the various components, a number of attenuation equalizers are used depending upon the type of facility. For example, Fig. 9 shows the loss frequency characteristic of a *226P* equalizer used at television operating centers to control roll off. Fig. 10 shows the loss frequency characteristic of the *226F*, *G*, and *H* equalizers which are used, for example, on television loops to television stations and on some other facilities.

CONCLUSIONS

It can be concluded from the discussion that the transmission of color-video material introduces requirements which, although definitely of minor concern in monochrome transmission, are of major importance when color video is transmitted. For this reason, considerable work was required to make video facilities suitable for color transmission although they were entirely satisfactory for monochrome transmission.

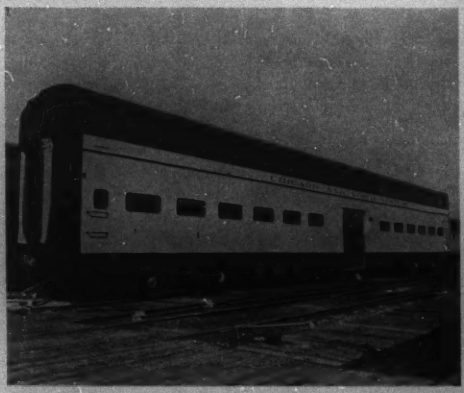
Lighting Generators for Biggest Commuter Cars

The new streamlined air-conditioned coaches of double-deck design which the Chicago and North Western Railway Company is placing in suburban service have generator units of fully automatic operation. These cars, which boast the largest seating capacity of any railroad equipment in the United States, have independent engine-driven generators of ample capacity to provide extensive lighting of both "decks" in the gallery-type cars.

The roll-out generator sets are powered by 4-cylinder internal combustion engines operating on propane fuel. The 20-hp engines are close-coupled to special 9-kw railway-type generators built by Harnischfeger Corporation, Milwaukee, Wis.

The generators have been specially engineered for rail service and under-coach installation, meeting requirements for compact size. Design is fully enclosed, providing positive protection against moisture, dirt, and weather.

The generators operate at a constant speed and maintain a constant voltage at all times. A direct-driven fan provides effective cooling. The generator shell has finned surfaces for rapid heat dissipation.



New giant commuter railway cars of the type shown above utilize especially designed 4-cylinder butane engine-driven generators to provide extensive lighting service on both decks

Applications of Statistics to Motor Testing

J. L. OLDENKAMP
ASSOCIATE MEMBER AIEE

IN the performance testing of fractional-horsepower motors a great deal of variation in test results occurs because of: (1) variation between motors; (2) bias on the part of the testers; (3) inability to control all test conditions.

Therefore, if a new design of motor is built, the test results from one experimental motor will give only an approximate indication of the characteristics of a typical motor of the new design. It would be desirable to know how accurate this estimate of typical performance is, and how the estimate can be improved.

The problem was analyzed by testing three types of motors, with a sample of six motors of each type, and by testing each motor three times. The motors were tested in different order by different testers each time; none of the testers knew that the motors had been tested previously.

The test results were evaluated by means of an analysis of variance.[1–9] With the aid of this tool it was possible to calculate the three components of variance. This made it possible to calculate the deviation of the average values of the sample group from the average value of the entire population. This deviation for a sample of M motors tested T times is given by

$$\sigma = \sqrt{\frac{\sigma_M^2}{M} + \frac{\sigma_T^2}{T} + \frac{\sigma_0^2}{MT}}$$

where

σ = deviation of average of samples from average of whole population.
σ_M^2 = component of variance due to motors.
σ_T^2 = component of variance due to tester bias.
σ_0^2 = component of variance due to inability to control test conditions.

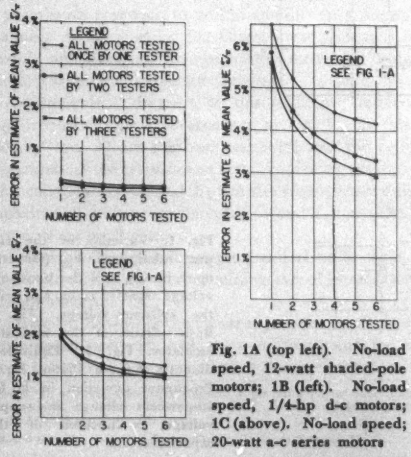

LEGEND
ALL MOTORS TESTED ONCE BY ONE TESTER
ALL MOTORS TESTED BY TWO TESTERS
ALL MOTORS TESTED BY THREE TESTERS
LEGEND
SEE FIG 1-A
ERROR IN ESTIMATE OF MEAN VALUE
NUMBER OF MOTORS TESTED

Fig. 1A (top left). No-load speed, 12-watt shaded-pole motors; 1B (left). No-load speed, 1/4-hp d-c motors; 1C (above). No-load speed; 20-watt a-c series motors

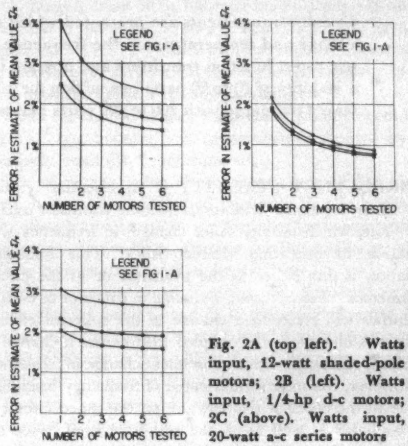


Fig. 2A (top left). Watts input, 12-watt shaded-pole motors; 2B (left). Watts input, 1/4-hp d-c motors; 2C (above). Watts input, 20-watt a-c series motors

Figs. 1*A*, 1*B*, and 1*C* give the error of estimate of no-load speed of three types of motors; Figs. 2*A*, 2*B*, and 2*C* give the error of estimate of full-load watts input. These figures indicate that estimates of performance may be inaccurate if based on one test only. In 32 per cent of the cases the error will be larger than that indicated by the graphs, and in 4.6 per cent of the cases it will be more than twice as large. The graphs also show that in some cases, where tester bias is larger than variation between motors, the estimate of error is reduced more by having two testers test the same motor than by building two motors and allowing only one tester to test them.

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J. L. **Oldenkamp** is with General Electric Company, Fort Wayne, Ind.

Stable Transistor Oscillator

EDWARD KEONJIAN

Circuit arrangements are presented which considerably reduce the effect of changes in supply voltage and temperature on the frequency of a transistor oscillator. The oscillators described use n-p-n junction transistors and operate in the frequency range of 1 to 2 mc. In this range, a stability of 10 to 20 parts per million for 10-per-cent changes in supply voltage have been obtained compared with 200 to 400 parts per million for the same change in unstabilized oscillators.

FREQUENCY STABILITY is an essential requirement for many oscillators, including transistor oscillators, which usually suffer changes in frequency with variation in operating characteristics. This frequency variation is due either to the transistor or to the circuit parameters. For example, a change in collector or emitter potentials will result in a change in the collector capacitance. A change in the coupled load causes a change in the shunt resistance with a consequent change in frequency.

However, the most serious cause of frequency instability is due to the effect of temperature on the tuned circuit of the oscillator as well as on the transistor itself, since the parameters of the transistor also vary with the temperature.

There are several measures which may be taken in order to improve the stability of the transistor oscillator. However, even in the case of a perfect stabilization, the frequency stability of an oscillator can never exceed that of its frequency-controlling element (e.g. the tank circuit), unless there is a special means which provides a compensation for any frequency shift which is due to the controlling element. Therefore, by considering the merits of different oscillator circuits, it is convenient in each case to assume that the frequency-controlling element by itself is stable, and to examine the extent to which the frequency is changed by the presence of the transistor.

EFFECT OF SUPPLY VOLTAGE

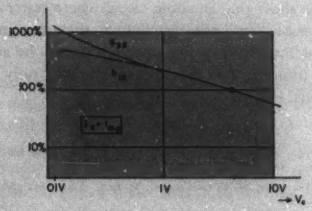
ONE OF THE PARAMETERS OF JUNCTION TRANSISTORS which affects the frequency-controlling element of the transistor oscillator and hence the frequency of oscillation, is the collector-to-base capacitance of transistor. This capacitance can be expressed in the following form:[1,2]

$$C = 0.071 d^2 \frac{1}{\sqrt{\rho_b V_c}} \text{ (micromicrofarads)}$$

where d = diameter of the junction in mils

V_c = collector voltage

ρ_b = resistivity of base material in ohm-centimeters



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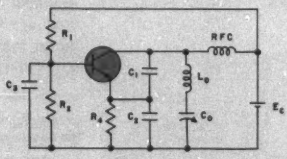

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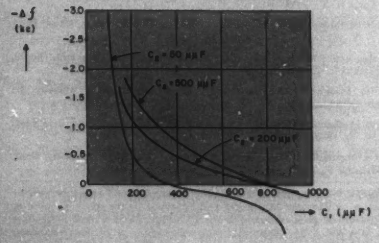

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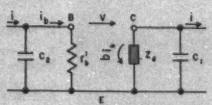

3

Fig. 1. Variation of the output admittance, h_{22} (for the open input), and the backward voltage transfer ratio, h_{12}, with the collector voltage. Fig. 2. Basic circuit of the transistor oscillator. Fig. 3. Equivalent diagram of the oscillator. Fig. 4. Frequency deviation in kc for 10-per-cent change in supply voltage, as functions of the capacitance C_1.

The magnitude of this capacitance can vary from few to several hundred micromicrofarads, depending on the construction of the transistor and its collector voltage.

Therefore, for the given transistor, the variation of collector voltage can seriously influence the operating frequency of the transistor oscillator, particularly when external capacitances of the oscillator are small.

In terms of the grounded base h parameters of transistor, the effect of the collector voltage can be seen in Fig. 1, where the curve for h_{22} represents the variation of the output admittance (for the open input), and H_{12} represents the variation of the backward voltage transfer ratio, with the collector voltage.[3]

In view of these facts, the stabilization of the collector voltage and operating point of the transistor oscillator is one of the important requirements for the frequency stability.

If the supply voltage of the transistor cannot be maintained constant, then some form of compensation network must be used which will minimize the influence of the transistor parameters on the frequency of oscillation.

Llewellyn[4] has shown that the frequency of oscillation of the tube oscillator can be made almost independent of the parameters of the tube by inserting suitable reactances in series with the grid or with plate or both.

However, values of these compensating reactances depend upon frequency. Therefore this method is not suitable for the variable-frequency oscillators. In addition, by applying Llewellyn's method to the transistor oscillator, the compensating reactances under some conditions might have unreasonable values, which will affect the operation of the oscillator.

Clapp[5] has shown that a good stability against variation of the tube parameters as a result of changes in supply voltages can be achieved by substituting the tuning inductance of the Colpitts circuit with a series inductance-capacitance circuit.

A transistorized version of this type of oscillator is shown in Fig. 2. This oscillator has as good stability as the Colpitts oscillator properly adjusted for optimum stability. However, the great advantage of the Clapp oscillator is that it permits an approach to perfect stability in a noncritical manner. Consequently, the Clapp arrangement is more flexible and does not require readjustments for optimum stability when the frequency changes.

An equivalent diagram of this oscillator derived for high-frequency operation is shown in Fig. 3. In this circuit, r_b' and Z_d are the base resistance and the collector impedance of the transistor at high frequencies, respectively. The capacitances C_1 and C_2 are the frequency-stabilizing capacitances which together with C_0 and L_0 form the tank circuit of the oscillator.

This equivalent circuit permits the derivation of the condition for oscillation, and obtaining the expansion for frequency stability.

However, in view of the fact that practically all the transistor parameters vary with the operating point, the equations become so complicated that their practical value is very doubtful. Therefore, this investigation was carried out experimentally at the operating frequency of 1 mc and was restricted only to the problem of the frequency stability as it is influenced by the capacitances C_1 and C_2.

Fig. 4 shows the frequency deviation in kilocycles for a 10-per-cent change in supply voltage, as a function of the capacitance C_1. The curves were taken for different values of C_2, ranging from 50 to 700 micromicrofarads. It can be seen that a large C_1 is always desirable. This is quite logical since C_1 is in parallel with the collector capacitance C_c, therefore the larger C_1 is the less is the variation of the total capacitance with the supply voltage.

These curves also indicate no great advantage from having C_2 large, because this capacitance is shunted by the relatively small (2k. Ω) resistance R_4.

The maximum value of the capacitance C_1 (for higher frequency stability) is limited primarily by the loading of the collector circuit and by the fact that the capacitance C_1 also serves as a feedback element for the oscillator which affects the operation point of the oscillator.

Preliminary experimental results with the oscillator have shown that by using C_1 and C_2 in the order of a few hundreds of micromicrofarads, noncritical stability in the order of 200 to 400 parts per million, for 10-per-cent changes in supply voltage, can be easily obtained.

Due to the intermodulation of harmonic components generated by the nonlinear characteristic of the transistor, there is a phase shift which changes the phase angle of the input impedance of the transistor. Accordingly, the frequency of operation becomes sensitive to the amount and distribution of the harmonics in the oscillator circuit. Therefore another important problem of the frequency stabilization will be in the operation in the linear portion of the transistor characteristic to keep the amplitude of the harmonics at a minimum. This requires the use of some form of limiter in the oscillator circuit.

Such a limiter is particularly important for the variable-frequency oscillators, since in most oscillators the amplitude of the oscillation varies to a certain extent with the tuning.

A simple circuit arrangement based on controlling the base current of transistor, which reduces the amplitude variation in the frequency range 1 to 2 mc by a factor of almost five, is shown in Fig. 5. In this circuit, diode D biased negatively is connected between points (a) and (b). When oscillation starts and the amplitude swing across condenser C_0 exceeds the cutoff voltage of the diode, it starts to conduct, giving rise to the current through the resistance R_4. Consequently, the base current of the transistor is reduced, thereby reducing the amplitude of oscillation until it reaches the cutoff voltage of the diode D. The direct voltage across condenser C_0 is used as the reference source and the magnitude of cutoff voltage could be adjusted for the desired value by the potentiometer P.

A circuit arrangement is given in Fig. 6 which can be used to minimize the effect of the variation of supply voltage on the operating point and hence on the frequency of oscillation.

In this circuit an auxiliary transistor, 2, and a voltage divider, R_{11}–R_{13}, are employed.

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Edward Keonjian is with the General Electric Company, Syracuse, N. Y.

When the supply voltage E_c changes, the base current of transistor 2 also changes and hence the collector current, I_{c2}, of this transistor will be changed. The current in R is the sum of I_{c2} and the direct current which flows in the voltage divider R_4 and R_3. Consequently, changes in this current will change the bias of transistor 1. (For the connections used in Fig. 9 this bias will be more positive for small values of E_c and less positive for large values of E_c.)

If the characteristic of transistor 2 is properly adjusted, the bias of transistor 1 will vary with variations of E_c in such a way that the frequency of oscillation will be practically independent of E_c (within certain limits of E_c).

The results of the experimental test of this circuit are shown in Fig. 7, which is a plot of the frequency deviation vs. supply-voltage characteristics for uncompensated and compensated oscillators. From these preliminary curves it can be seen that the proposed method already improves the stability of the oscillator from 6 (E_c = 14 volts) to 24 times (E_c = 10 volts).

EFFECT OF TEMPERATURE

THE MOST UNFORTUNATE PHENOMENON which is observed by every one who works with transistors is the effect of temperature on the operation of the transistor. This is because practically all the parameters of transistors vary with temperature, which, unlike the supply voltage, is very difficult to control.

One of the transistor parameters which is affected most by the temperature variation, is the collector back current, I_{co}. This current increases exponentially with the temperature and could be expressed as

$$I_{co} = I'_{co} e^{\epsilon(T - T_1)}$$

where I'_{co} is the magnitude of the collector back current, I_{co}, at the temperature T_1. For most junction transistors, the value of the constant ϵ is between 0.06 and 0.08 per degree C. (Because of leakage, this equation does not usually hold well at very low temperatures.) Consequently, the collector current of the transistor, which can be expressed as

$$I_c = \alpha I_e + I_{co}$$

will vary with the temperature, which will change the static characteristics of the transistor, hence the operating point of the transistor.

This change of operating point will in turn change the emitter current and collector voltage of the transistor, and consequently almost all the parameters of transistor. See Fig. 1. As far as the frequency of the oscillator is concerned, it was observed that for the conventional direction of base current, the net result of the temperature on the frequency of oscillation is extremely strong, and the frequency decreases rapidly as temperature rises.

Analyzing the circuit diagram of Fig. 2, one can see that capacitance C_2 is one of the frequency-determining elements. This capacitance, which is shunted by resistance R_4, is also in parallel with the "diffusion" capacitance given approximately by [2]

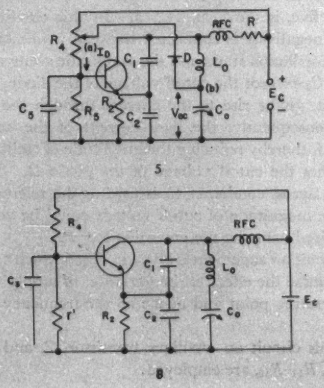
$$C_{b'e} = \frac{q}{kT} \frac{\omega^2 I_E}{2D}$$

where ω is the effective thickness of the base region, I_e is the direct emitter current, D the diffusion constant for minority carriers in the base region, q the electronic charge, k Boltzimann's constant, and T the absolute temperature. This capacitance, which may have a value up to several thousand micromicrofarads, is proportional to the emitter current of the transistor. Therefore, by controlling the magnitude of this current, one can control the capacitance $C_{b'e}$, hence the frequency of oscillation.

As mentioned previously, a temperature rise decreases the frequency, therefore this effect can be compensated by decrease of capacitance $C_{b'e}$ which suggests the decrease of I_e as the temperature rises. This can be done conveniently by replacing the resistance R_3 in Fig. 2 by a temperature-sensitive resistance with a negative temperature coefficient. This type of resistance, thermister, changes its value with temperature in accordance with the relationship

$$R = R_0 \cdot e^{B\left(\frac{1}{T} - \frac{1}{T_0}\right)}$$

when T_0 is the reference temperature in degrees Kelvin



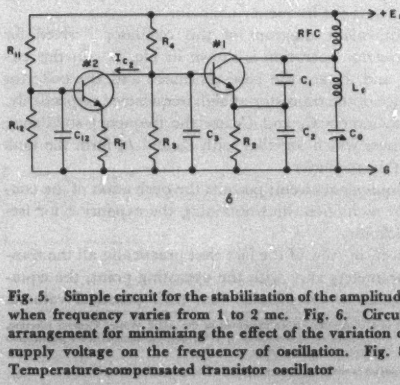


Fig. 5. Simple circuit for the stabilization of the amplitude when frequency varies from 1 to 2 mc. Fig. 6. Circuit arrangement for minimizing the effect of the variation of supply voltage on the frequency of oscillation. Fig. 8. Temperature-compensated transistor oscillator

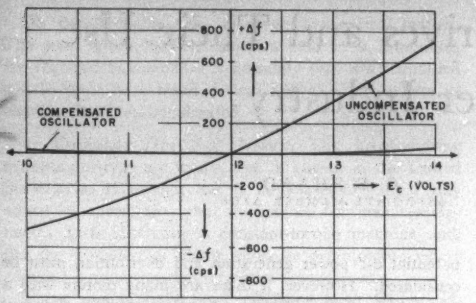


Fig. 7. Frequency deviation vs. supply voltage characteristics for uncompensated and compensated oscillators

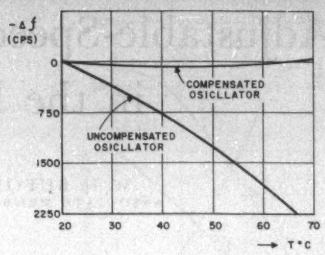


Fig. 9. Frequency deviation vs. temperature characteristics for uncompensated and compensated oscillators

(for room temperature $1/T_0 = 0.00335$), T the temperature of the resistance in degrees Kelvin, R_0 the resistance at temperature T_0, and B a temperature constant which may have a value of several thousand degrees Kelvin.

A practical embodiment of this idea is shown in Fig. 8, which represents an oscillator operating on a *n-p-n* junction transistor. Resistor R_4 and r' form a voltage divider which supplies the bias for this transistor. Resistance R_4 is an ordinary linear resistance while r' is a temperature-sensitive resistance with the negative temperature coefficient.

By proper choice of coefficient B of resistance r', the effect of the temperature on the oscillating frequency can be minimized. This principle was confirmed experimentally. Fig. 9 shows the frequency deviation vs. temperature characteristics for uncompensated and compensated oscillators. From these preliminary curves it can be seen that the proposed method already improves the stability of the oscillator from 20 to 35 times, for temperature ranges from 45 C to 60 C respectively. It is also possible to combine this circuit with the circuit shown previously, see Fig. 6, for the simultaneous compensation of temperature and of supply voltage variations.

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Testing Tower for Landing Gear

Duplicating actual aircraft landing conditions, a 40-foot drop test tower at Lockhead Aircraft Corporation's research center, Burbank, Calif., is being used in the development of lighter, stronger landing gear. In the test mechanism, a moving platform carrying lead weights equal to half the mass of the airplane is raised specified distances above the contact position and dropped to simulate a plane landing.

Strain-gauge load and displacement measuring devices built by Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa., determine the motions of the gear in space and the forces applied to it during the landing period. The entire loading period is about 0.1 second.

During the landing gear tests the wheels are rotated backward to simulate the forward motion of the airplane at landing. Impact with the ground stops the wheels in a fraction of a second, causing large drag loads in the fore and after direction in the gear, in addition to vertical loads in stopping the moving weight.

Strain gauges are utilized primarily because of their better frequency response characteristics.

Adjustable-Speed Drives and Their Use in the Paper Industry

W. H. BUFORD
ASSOCIATE MEMBER AIEE

G. E. SHAAD
ASSOCIATE MEMBER AIEE

Adjustable-speed drives of small and medium horsepower are divided into seven types and the general characteristics of each are described and compared with reference to their application in the paper industry. Mill experience suggests that the flexibility of the adjustable-voltage d-c drive and the simplicity of the wound-rotor drive are satisfactory for most drive applications.

AT THE PRESENT TIME, the Hodge, La., mill of Southern Advance Bag and Paper Company operates a wide variety of paper-mill equipment that requires or can economically justify adjustable-speed drives. Most of these fall in the small to medium horsepower range of 1 to 75 hp, and as a result there are a number of possible drive selections, each of which has certain advantages and disadvantages. At Hodge certain drives were selected upon the basis of the drive characteristics, the requirements of the driven machines, and past experience in the operation and maintenance of similar drives. Another mill, for similar reasons, might choose other drives and have equally satisfactory results.

Looking at the broad field of adjustable-speed drives, they fall into roughly seven types, with each type having certain general characteristics.

1. Constant-Voltage D-C Drives. Such drives are by nature constant-horsepower drives although tapered motor ratings are the result of increased motor ventilation at the higher motor speeds. Therefore for constant-torque applications, the motor is larger and more expensive than an equivalent adjustable-voltage constant-torque d-c motor.

Depending upon the horsepower involved, these field-controlled motors can be obtained with speed ranges as high as 7 or 8 to 1 with the general motor design providing a 3 or 4 to 1 speed range. Additional speed range beyond the field-control range can be obtained by armature rheostat control with or without armature shunting resistors as may be desired. In the field-control range, these motors are readily controlled and give very satisfactory performance. They require added space at the machine and the starting characteristics are such as to give high starting torque unless rather special control is provided.

In the consideration of such drives, the cost of constant potential d-c power generation and distribution must be considered. However, if there are many motors with a great deal of diversification, it may be an economical system.

2. Adjustable-Voltage D-C Drives. These are the most flexible of all drive systems for they can be designed for nearly any combination of constant torque or constant horsepower, any speed range, and any desired starting characteristics. The adjustable-voltage supply may be Thyratron tubes, rotating d-c generators of packaged or nonpackaged construction, and even ignitron rectifiers, for the larger sizes. The equipment and functions naturally will depend upon the particular drive size and drive requirements. For general use the motor-generator (m-g) set is the most universal of the power supplies, with the packaged drives being very convenient for installation. A typical packaged m-g set is shown in Fig. 1.

In general, more total floor space is required for this type of drive, but the floor space at the driven machine is kept at a minimum. There are more commutators, bearings, etc., to maintain, but these are matters of common routine maintenance. Where rapid reversing, regenerative braking, or similar functions are required, the adjustable-voltage d-c drive becomes the natural selection.

3. Wound-Rotor A-C Motors. The wound-rotor motor is a constant-torque motor that is quite inefficient at reduced speed operation. The difference between the power input to the rotor and the power output from the rotor shaft is lost in the secondary resistors. Since the power input is constant for a constant torque, the efficiency drops off directly with speed on a constant-torque load. Where pump or fan loads are involved or where only short-time operation is involved, this loss of efficiency may be unimportant.

Of more importance on the average small installation is the fact that the inherent speed regulation of a wound-rotor motor becomes increasingly poorer as speed is reduced. This is shown in Fig. 2. As an example, if a wound-rotor drive were operating at 100-per-cent torque and 20-per-cent speed, a decrease in load torque to 80-per-cent torque would increase the operating speed to approximately 35-per-cent speed, a 75-per-cent change in operating speed.

The starting torque of wound-rotor motor drives can be kept very low by suitable secondary resistors, but stepless speed control is very expensive and in general is unavailable. Consequently, only a limited number of speed points are available.

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W. H. Buford is with the Southern Advance Bag and Paper Division of Robert Gair Company, Inc., Hodge, La., and G. E. Shaad is with the General Electric Company, Schenectady, N. Y.

On the favorable side, however, are several factors: The total space requirements are held to a minimum; the required maintenance is normally very low; installed cost is low. As a result, it is a logical choice where its characteristics can be tolerated.

4. Commutator-Type A-C Motors. The brush-shifting commutator-type a-c motor, Fig. 3, known in the United States as an *ACA* motor, has the advantage of being a truly adjustable-speed drive that requires no conversion equipment. It is inherently a constant-torque machine and, like the wound-rotor motor, must be overmotored where constant-horsepower characteristics are required.

These motors have good efficiency with fair speed-regulation characteristics at reduced speeds and are available with speed ranges as high as 20 to 1. Below their basic speed, their characteristic is similar to a wound-rotor motor. Since no conversion equipment or secondary resistors are required, the total floor space is kept at a minimum.

For automatic control, the *ACA* is somewhat limited since the brush assembly must be mechanically moved. For nonautomatic operation, either manual- or motor-operated brush shifting can be used. The starting characteristic gives a fairly high starting torque unless special control is provided.

In paper mill applications with the prevailing corrosive conditions, the inability to obtain *ACA* motors in totally enclosed construction somewhat limits their application.

5. Magnetic Slip Couplings. These are similar in many characteristics to the wound-rotor motor with the speed torque characteristic being changed by excitation adjustment rather than secondary resistors. See Fig. 4. An essentially stepless control can consequently be obtained with relatively inexpensive control. For most applications this ability to obtain stepless adjustment is not by itself sufficient improvement over a wound-rotor motor. A speed-regulating system of electronic or magnetic-amplifier type is therefore usually used to regulate speed to approximately the setting called for by the operator or by the automatic control system.

The larger air-cooled units are limited in their heat-dissipating ability, and where long operation at rated torque and low speed are involved, either oversized units or multispeed drive motors should be considered. Where dust or corrosive conditions prevail, the water-cooled couplings are a possible solution to the cooling problem.

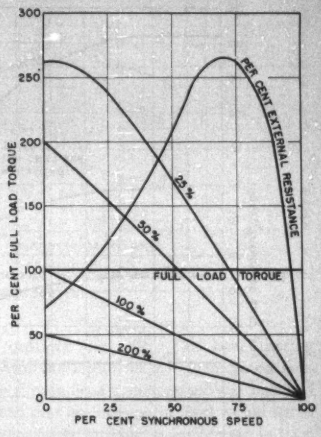


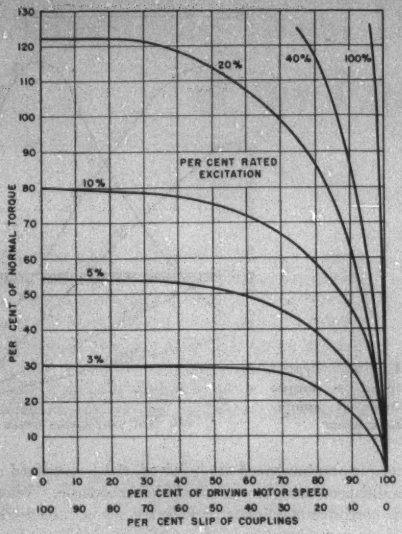
Fig. 2. Typical speed – torque curve of wound-rotor motor

6. Hydraulic Couplings and Drives. There is a wide variety of hydraulic drives ranging from the positive-displacement systems to the torque-converter couplings. For general-purpose drives, however, the most common are the adjustable-speed hydraulic couplings and the hydraulic-torque converter. These two drives have some similarity but have rather radical differences in actual design and in their torque characteristics.

The adjustable-speed hydraulic couplings, like a non-regulated magnetic slip coupling, can have a very smooth starting torque and stepless speed control by varying the amount of liquid in the coupling. Also, like the magnetic slip coupling, the efficiency is proportional to speed and at high slip the increased losses may require special attention to cooling the coupling.

The hydraulic torque converter, shown in Fig. 5, has a considerably different set of efficiency and torque charac-

Fig. 1 (left). Packaged speed variator for winder drive. Fig. 3 (right). ACA brush-shifting commutator-type a-c motor driving processing lines



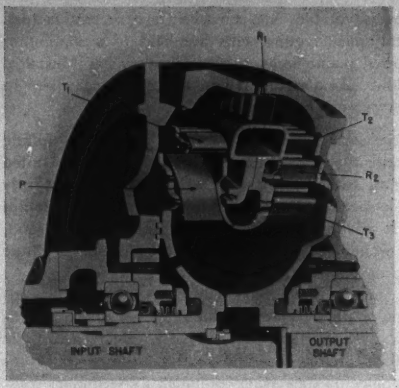


Fig. 4 (left). Magnetic slip coupling–torque characteristics. Fig. 5 (above). Cross section of hydraulic torque converter shaded longitudinal section of top half

teristics with a typical set of curves. See Fig. 6. By modification of these curves plus a variable input speed, such drives can be used for constant-horsepower applications with satisfactory results where accuracy and efficiency are not extremely important.

7. *Mechanical Speed Changers.* The mechanical speed-changing drives depend upon changing the ratio between the driving and the driven sheave to vary the speed of the driven sheave. They vary from those adjustable only at standstill to rather complex automatically controlled systems, and their costs vary accordingly.

Their mechanical characteristics are a cross between constant torque and constant horsepower. In general they are suitable for increased torque at reduced output speeds but not in sufficient magnitude to have constant-horsepower characteristics. Their major drawbacks are the mechanical wear with its resultant maintenance, the required mechanical motion for remote or automatic control, and the space requirements at the driven machine. In small sizes, their initial cost is apt to be quite low.

From these basic types of drives it was necessary to decide upon the type of drive and the construction of drive best suited to the various applications. These included bag machines, roll printers, stock washers, stock thickeners, saveralls, tubing machines, conveyors, winders, etc.

The first of these installations was an individual bag-machine drive that had been driven from a line shaft similar to that shown in Fig. 7. The selection of the drive was dictated by circumstances since 115-volt d-c constant potential and a 2-kw d-c generator (from the lighting supply of an oil-well drilling rig) were available. The drive was arranged with series rheostat control using the 2-kw generator as a motor operating from the 115-volt bus. Naturally with series rheostat control, the regulation over the speed range was rather poor but the increased production potential was demonstrated and was the determining factor in eventually changing all of the bag-machine drives over to individual d-c motors. In the period of 1 month, the machine with the individual d-c drive produced almost twice as much as a similar machine with the line-shaft drive. This was the result of less starting shock and a resultant ability to start and run with the machines geared for higher running speeds. A second desirable factor was the increased safety and convenience resulting from the elimination of the common line shaft.

For best operation of these machines, the drive requirements included flexibility, soft starting, good speed regulation, simplicity, and low maintenance. The adjustable-voltage d-c system seemed to offer the most economical way of obtaining these features. Packaged drives, as they are known today, were not available at that time so units were assembled at the mill into a package for flexibility and transportation. M-g sets were of dripproof construction while the motors were totally enclosed and fan cooled, for of necessity they were mounted where they would be covered with bagpaste, oil, and paper dust. Typical of the units and their installation is the balcony line-up of m-g sets and control shown in Fig. 8.

Initially an exciter was used on each m-g set, but this has now been changed to group excitation. The maintenance of a single excitation set at 1,750 rpm has been found to be very small in comparison to 25 to 30 small high-speed exciters.

In regard to the sets themselves, there have been objections by many users to 3,600-rpm m-g sets. While this may be justified in some cases, it means changing from 3,600 to 1,800 rpm with a consequent increase in the size

and cost of the unit. The mounting space required for the slower speed sets would be appreciably increased and this in itself would bring on problems since space is always a factor to be considered. Experience with these units, particularly on bag machines where they frequently must be moved from one location to another, has led to a preference for the smaller sets with reduced plant investment and with the greatest ease of handling. Mill experience, however, definitely indicates that group or rectifier excitation is preferable to either direct-connected or belted exciters on these sets.

It must be admitted that in the larger units, lower speeds would have some advantages in brush wear, commutator wear, vibration, and bearing wear; the m-g set location and the possible need for 100-per-cent availability will determine how much can be spent to obtain these advantages.

As is natural, some other drives have been installed for comparative operation. Instead of the conventional generator shunt field rheostat control, some of the series circuit drives were used. They were not as satisfactory to the operators, since the stalled torque was excessive and there was creeping as a result. Some tube-type equipments have been used and while they give good operational performance the tube life has been quite short. With present tube life, it would not be economical to operate a large number of units.

On the stock washers and thickeners and on the savealls, which incidentally are vital to paper manufacture, the same type of d-c adjustable-voltage drives of similar construction and with group excitation are used. The flexibility and simplicity have given excellent results. For example, on the saveall, which filters and saves the otherwise wasted fiber from the fourdrinier of the paper machine, the filter cylinder is driven by a 10-hp motor. This incidentally is

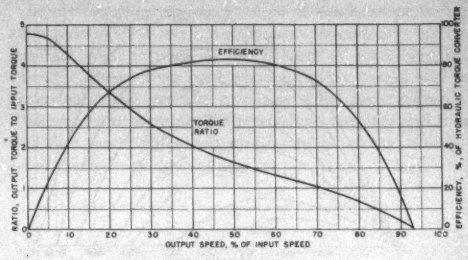


Fig. 6. Speed–torque and efficiency characteristics of a typical 3-stage hydraulic torque converter

the standard size unit for the mill. The best filtering efficiency results when the liquid level is maintained constant. Therefore a simple float arrangement was installed on the saveall tank so that an increase in level would speed up the cylinder giving faster filtering or a decrease in level would slow down the cylinder and thus slow down the filtering. The simplicity of such a system, shown in Fig. 9, makes it easy to adjust and maintain, whereas a previous complex pressure system was not satisfactory. The only problem now is with the rheostat assembly which must periodically be replaced.

In paper mill operations where equipment must operate 24 hours per day, 7 days per week, it is good practice to keep the installations as simple as possible with the fewest number of pieces. The use of magnetic slip couplings for such drives has been considered, but the problem of cooling air and the corrosive atmosphere have not made them particularly attractive on a long-term basis.

The same small d-c adjustable-voltage systems have met the needs for the screw conveyors handling saltcake

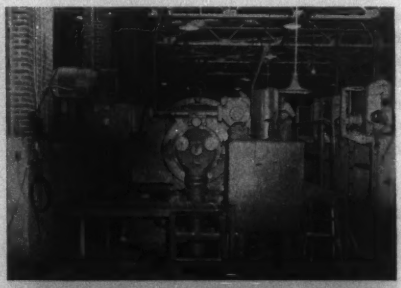


Fig. 7 (above). Typical lineshaft drive arrangement. Fig. 8 (right). Line-up of m-g sets and controls. Fig. 9 (top right). Level-controlled saveall drive

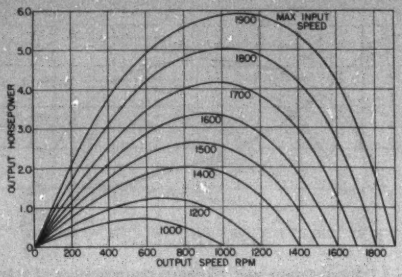


Fig. 10. Typical hydraulic torque converter characteristics with varied input speeds

in the recovery furnace and lime in the caustic system, for the good speed regulation under varying loads keeps the speeds constant and the adjustable speed makes it easier to get accurate quantities of chemicals into the system. Likewise on the bark-burner conveyor, which handles the waste bark that has been dried and pulverized for fuel, a 10-hp d-c adjustable-voltage drive provides the controlled feed necessary for burner operation.

An interesting combination of an adjustable-voltage d-c drive and a torque converter has been used experimentally and seems to have good possibilities. For a winding or unwinding operation it is believed that some good applications could be worked out.

The combination of the adjustable-speed d-c motor and the torque converter provides the set of speed–power curves shown in Fig. 10 and the result is a fairly uniform winding tension over a wide range of tensions.

By changing the speed of the d-c motor as the load is increased or decreased, the output shaft of the torque converter will exert a fairly uniform tension with one setting of the motor field rheostat. The load determines the setting of the motor field rheostat.

While the efficiency of such a unit is apparently very low, the amount of power used on small applications may be low enough to not be a consideration. From a maintenance standpoint also, the application could be looked on as very good.

On the large "Sebolt Cutter," which takes paper from 10 or 12 rolls of paper and cuts it into standard-size sheets, a wound-rotor motor is operating satisfactorily. The advantages of stepless control or better speed regulation do not justify a change. If a new drive were required, however, a d-c drive would be considered.

Winder drives include both the adjustable-voltage d-c and the wound-rotor motor drives. While the d-c drive gives a more accurate control and a wider speed range, the slower speed standard-duty winders can be operated quite satisfactorily with wound-rotor motors such as shown in Fig. 11. The trend, however, is to higher speed winders with d-c drives. Since 1948, for example, the top speed of the no. 2 paper-machine winder has been increased from 2,100 feet per minute to over 4,000 feet per minute with still further speed-up in view. This has been necessary to keep the winder ahead of paper-machine production.

In a 7-year period, a change has been made from a 75- to a 100-hp wound-rotor motor, then to a 125-hp adjustable-voltage d-c drive, and then to a 200-hp adjustable-voltage d-c drive with amplidyne control. This single-motor mechanical-braking winder, shown in Fig. 12, operates on counter-roll production and the severe service conditions exemplify the flexibility of the adjustable-voltage d-c drive.

In the winding cycle, $5^1/_2$ to 6 tons of paper must be accelerated to 4,000 feet per minute in 12 to 15 seconds, a set of 9-inch rolls of paper be wound in 15 to 20 seconds, and the winder stopped in 8 to 10 seconds. On 40-pound butcher paper, we have averaged one set of 9-inch counter rolls a minute in production.

This is a typical installation where the increased cooling available by forced ventilation of the motor enables the equipment to be utilized to its best advantage. If forced ventilation were not used, very little cooling would be obtained during roll changes or at low-speed operation, and the duty cycle would have to be reduced.

There are very few mechanical speed changers in the mill, for it is the feeling that they are primarily designed for intermittent duty. Under light duty they seem to stand up very well, but for continuous service under paper-mill conditions the best and most economical way to take care of an adjustable-speed drive is to vary the speed with the motor rather than an accessory. None of the d-c drives

Fig. 11. Wound-rotor motor driving winder

Fig. 12. 200-hp amplidyne-controlled winder drive

has ever been discarded, while quite a few mechanical systems have been eliminated.

Different mills will have different problems and may choose other types of drives for good reasons. From the mill experience, however, it is felt that the flexibility of the adjustable-voltage d-c drive and the simplicity of the wound-rotor drive will provide satisfactory answers to most of drive problems.

In the last 10 years, the number of machines requiring adjustable-speed drives has increased tremendously with a resulting great increase in the amount of equipment involved. These drives have unquestionably contributed a great deal to the increased efficiency of the paper industry. This trend can certainly be expected to continue and it is well that the selection and application of these adjustable-speed drives be given consideration.

The Roots of Automation

D. C. BURNHAM

The different views of automation held by labor, industry, and the man in the street are discussed as well as how automation has developed logically in an evolutionary way. Automation is also shown to be necessary even to maintain the present rate of improvement in the standard of living and therefore an absolute necessity for continued American progress.

NO ONE would argue with the statement that automation is today's most controversial subject. Labor calls it a monster, an industrial demon that threatens completely to destroy the American way. Industry, rising lately to its own defense, says it will result in more and better jobs, products, and purchasing power. The man on the street is confused.

Afraid of borrowing trouble, industry has been slow with its word on automation, far too slow. Now industry finds itself in the rather ridiculous position of having to defend a manufacturing technique that is not only logical but absolutely essential to the growth and well being of the United States. Labor has argued that industry has shrugged its responsibility as Americans by allowing automation to grow. The only responsibility that industry has shrugged is that of communicating to the people what automation is and what its effects will be. This is the engineer's challenge, and the challenge of every segment of industry that is at all connected with the growth of automation: to use every means at his disposal to make evident to the American people what automation is, how it has come about, and what it will result in.

Automation naturally has its roots in today's manufacturing history. It is no revolutionary concept. It is rather a next logical step in a low evolution. In today's shops are examples of the various phases or steps passed through on the way to automation. There are four of these: job shop, with the lowest volume and highest cost method of production; progressive line manufacturing where machines are arranged according to the work that must be done on the product; conveyorized line manufacture, where conveyors are used to carry parts from one machine to the other; and finally automation, with its high degree of automatic handling and control. The roots of automation can be clearly traced through these four phases back to the beginning of manufacturing.

The job shop is undoubtedly the oldest method of manufacturing still in existence today. Parts are individually handled, individually machined, and assembled by hand. At the turn of the century, with few exceptions, this was the only method of manufacturing in existence for most industries.

An automobile, which costs $3,000 today, would cost approximately $100,000 if it were manufactured by job-shop methods at present labor rates. Obviously, the automotive industry would be very small if such were the case. Not only that, so would many supplier industries, including the machine tool industry.

Faced with an expanding and eager population, American industry had to find a way around the tremendous cost of hand labor. Someone conceived the idea of arranging the machines in his shop so that the part to be produced progressed in a straight line from machine to machine. This cut down on handling costs, boosted productivity. All this time, more efficient machine tools were being built that not only saved the worker's back and his eyes but produced more parts per hour. The next step up the scale from straight-line manufacturing was as inevitable as automation is today.

The assembly line or conveyorized method was to mark the United States as a nation unparalleled in producing high-quality low-cost goods. Although Henry Ford was not the originator of the conveyorized method of manu-

Essentially full text of an address presented at the 19th Annual Machine Tool Electrification Forum, Buffalo, N. Y., April 19–20, 1955.

D. C. Burnham is with Westinghouse Electric Corporation, Pittsburgh, Pa.

facture, he can be credited as being its greatest scholar. Ford announced in 1909 that he would "build a motorcar for the great multitude" and that he proposed to do it by building 1,000 cars a day. What it did for the United States is written in almost every minute of our present-day life. The words "United States" and "mass production" were to become complementary. The techniques of mass production have fitted in so well with the young ambitious democratic American way that it has not only made the United States the strongest nation in the world but has also played a major role in preserving the democracy that made mass production possible in the first place.

The step from conveyorized manufacture to what is called automation involves the use of more automatic machines and controls as well as automatic handling between machines. It is most certainly the next logical step in the progress of American productivity and undoubtedly not the last one. What has it done to the American people? Like every major technological advance in history, it has been accompanied by a corresponding rise in the standard of living by providing more jobs, better working conditions, and higher over-all pay. Citing again the automotive working industry, the effect of the automatic transfer machine on the automotive working population can be studied. The big advances in the use of automatic machinery in the automotive industry have been made since the war; and it is interesting to note that the number of people employed by the automotive industry has increased by 39 per cent since 1946. Automation is not a social plague; it is an economic necessity.

What does industry hope to gain by this steady progression? The answer is simple: It hopes to stay alive. So long as the American democracy exists, so will the simple law of supply and demand govern its economy. Any time your competitor can produce a comparable or a better product at a lower cost than you can, he is going to prosper at your expense. That, after all, is the basis of business. And not only is industry bound to this ironclad check and balance system, it is also supplied with the same conscience of democracy given to every American. Common sense indicates that industry would hardly want to produce goods in such a manner that it would destroy the democracy that provides for the very existence of industry to begin with.

Perhaps the present generation will never see the advent of the completely automatic factory, but if it does, it will be because people are ready for it. It will not upset the balance. It will come simply as another step in the long evolution, as an economic necessity. To fear such a step is to fear America itself.

How else will industry benefit from automation? The owners of industry have not been and probably will never be the major beneficiaries of automation. If it is to survive, industry must continue to plow back a great share of its earnings into the development of better products and techniques to meet competition. The industrial owner consequently finds himself on a very competitive merry-go-round where his per cent of the profits will most likely not change. The major beneficiaries are the consumers.

This is evident in American homes. Without the major advances in manufacturing technology, most likely there would still be some of the appliances available today, but they would be a far cry from present automatic labor-saving devices. And they would cost a lot more. Television, of course, would be nonexistent, and radio would be available only to a fortunate few. There would be no automatic washers, dryers, refrigerators, or electric blankets. Hardly anyone could afford them. It is apparent that industry is not alone in its need for automation.

How can it be attained? To quote a specific case: Westinghouse has in its organization examples of each of the four types of manufacturing mentioned. Not all of any one plant is in one specific stage, of course, but there are certain products that demand certain types of manufacturing, either because of the nature of the product or of the process. Large single-design steam turbines, for instance, would be difficult to conveyorize.

It is not realistic to expect to automate the job shop. But it can be raised to the next higher level of manufacturing. With additional investments in machinery and perhaps in floor area, any one of the manufacturing types can usually be raised one notch up the scale. This should be the goal of industry. With such an approach, economic automation can be realized.

Also, with this approach, if automation is accomplished in any operation, the change will come about naturally, slowly. There will be no sudden shift of workers. It is true that some workers may be displaced by automation, but this displacement will be gradual, paralleling the evolution of automation. The electrical industry, for instance, will double itself in the next 10 years and will employ an ever-increasing number of people.

Coupled with this approach, all the manufacturing know-how that can be mustered must be used. Perhaps the single biggest responsibility of the machine-tool builder in helping the growth of automation is to manufacture obsolescence of other people's machine tools. Although most companies have equipment-replacement programs, the machine tool industry should work hard at making present-day machine tools obsolete. Not only is this essential to the rapid growth of industry in general, but it is sure to be of considerable benefit to the machine-tool industry in particular. A higher percentage of engineering talent should be devoted to making this obsolescence come about. Machine tools should not have to be worn out. They should be made obsolete so they have to be replaced.

It also may be time to look carefully at the general structure of manufacturing organizations. Are they organized to attack efficiently the problems connected with automation? Manufacturing engineers, methods engineers, and plant layout experts are needed, each with sufficient freedom to discover new manufacturing methods and initiate action on them. And there are, of course, a great many other factors which must be continually re-evaluated if they are to be effective.

But the most important question to the confused man on the street is: What will automation do for me? As said, it will provide a higher standard of living, but there is more to it than that.

The defense of America, now as in the past, depends on

her ability to produce. In time of a major defense effort, the national production facilities are strained to the last man-hour. Automation then assumes the role of a vital defense mechanism. The excellent opportunities it presents should not be neglected.

There is another facet of America that makes automation a necessity. The working population and the total purchasing power of this nation are naturally closely allied. The gross national product is increasing at the rate of $3^1/_2$ per cent a year. However, the American working population is increasing at the rate of only 1.8 per cent a year. Something, somehow has to take up the slack if the United States is to continue to be able to produce to the level required to improve the current standard of living. Automation is that something. It helps the worker by providing him with means of being more productive. So automation is needed just to maintain the present rate of improvement in the standard of living.

The effect of automation or any other technological advance on the very young and the yet unborn Americans is of tremendous moral importance. Their education will be increasingly more vital. Largely as a result of automation, people will have more time, more money, and more need to go to school. The jobs they will be filling in industry will be more demanding of their talents and their mental powers than ever before. And as the educational level of industry increases, it will continue to complement industrial progress, thereby giving form to a still more advanced technology.

There are literally pages of corroborating data and favorable indications to support the industry claim that automation—far from being a demon—is an absolute necessity for American progress. This is a nation which will never see the limit of its potential in the present era. The United States' greatest asset of all is the ability to progress, to accept change, to adapt. It is inherent even in the system of government.

The problem that should be of greatest concern to the American people today is not how to stem the tide of automation but how to bring it about more quickly.

Nomenclature of Frequencies

G. B. RANSOM
FELLOW AIEE

The work which resulted in a proposed new system of nomenclature which may become the international standard within the next few years is outlined. It offers simplicity, ease of remembrance, the capability of expansion, and should prove useful to many other technical fields beside communication.

THE TERMINOLOGY used to designate subdivisions of the r-f spectrum has been under evolution and change since usage began. The present standard system is a development of that process but, in the opinion of many, has a limited field of application, and expansion for greater use appears impracticable. There have, therefore, been numerous suggestions for improving the system and study of possible revisions have been undertaken by technical societies in the United States as well as other countries. This article outlines the work which has led to a proposed new system of nomenclature which may become the international standard within the next few years. That proposal, though differing from the recommendations of the American technical societies, should prove to be a useful improvement over the present standard.

A special article recommended for publication by the AIEE Standards Committee.

G. B. Ransom was formerly the AIEE delegate to the Joint Committee on Standard Frequency Bands and Designations.

DEVELOPMENT OF PRESENT STANDARD

PROGRESS IN THE ART OF RADIO COMMUNICATION has brought into daily use many electromagnetic frequencies which previously had been of interest only in laboratories. As recently as 20 years ago, practical usage was limited to frequencies below 100 mc. Since the early days of radio there have been attempts to label descriptively the electric oscillations which were being used. Wavelength rather than frequency was the common terminology and the spectrum was divided into long, medium, short, and ultra-short waves. Later, these began to be referred to as low, medium, high, and very-high frequencies.

Led largely by radio people, the movement toward standard designations of frequency bands went forward and in 1937, meeting in Bucharest, Romania, the International Radio Consultative Committee (CCIR) of the International Telecommunications Union (ITU) considered the question and submitted a recommendation. This proposal, shown in Table I, was approved by the International Telecommunications and Radio Conference in Atlantic City, N. J., in 1947[1] and is the present standard. A metric subdivision of wavelengths is designated and adjectives are

used to name the individual bands. The Federal Communications Commission specifies this nomenclature in "Rules and Regulations" which it issues.

NEED FOR BROADER STANDARDS

USE OF THE PRESENT STANDARD SYSTEM OF DESIGNATION began before its official adoption, but the rate of expansion of the field of radiations progressed so rapidly that the inadequacy of the new system was recognized almost before it was officially adopted. It was observed that the terminology was not descriptive and the system does not permit practicable expansion at either the upper or lower end of the table established. Certainly, classification of all frequencies below 30 kc by a single name makes the term so broad as to be useless as a description. Obvious difficulty would be encountered in selecting adjectives which might describe additional bands and remembrance of the system would be impracticable.

The upper boundary of the radio spectrum is steadily moving upwards and classification of still higher frequency phenomena such as light waves and gamma and cosmic rays might be aided by subdivision of the spectrum. At the lower end of the scale there is increased use of frequencies ranging from 100 down to 1/100 cycles per second and lower. It seems clear that there is need for a classification system capable of broader application than the present one.

General agreement that an improved system was desirable led to committee activity on this question in the AIEE. About 10 years ago, a Joint Subcommittee on Standard Frequency Bands and Designations was established. The committee received many suggestions and the system which stimulated the most interest and acceptance was that of Professor H. M. Turner, which, with minor modifications, was published in May 1947.[2] This publication was an effort by the committee to determine the views of the AIEE members. The response, which was largely favorable, included a number of specific suggestions for further improvement of the proposal. Most of these were from those interested in expanding the scope of the system to include frequencies well below 1 cycle per second. Committee acceptance of some of the suggestions resulted in further modifications of the proposal. In August 1949, the system as it then had been developed was published.[3]

During the time that this work was going forward, the Institute of Radio Engineers (IRE) was also exploring the possibilities of a better system.[4] There was strong sentiment in IRE for a system of band limits which would coincide with metric subdivision of wavelength bands. This probably stemmed from the fact that many in that group had grown up with the wavelength system in the radio field. The IRE committee working on this subject developed a majority opinion in the institute, however, that it was not desirable or necessary to tie a proposed new system to the old.

Table I. Present Standard Nomenclature

Frequency Subdivision	Frequency Range*	Metric Subdivision
VLF (Very Low Frequency)	Below 30 kc	Myriametric waves
LF (Low Frequency)	30 to 300 kc	Kilometric waves
MF (Medium Frequency)	300 to 3,000 kc	Hectometric waves
HF (High Frequency)	3,000 to 30,000 kc	Decametric waves
VHF (Very High Frequency)	30,000 kc to 300 mc	Metric waves
UHF (Ultrahigh Frequency)	300 to 3,000 mc	Decimetric waves
SHF (Superhigh Frequency)	3,000 to 30,000 mc	Centimetric waves
EHF (Extremely High Frequency)	30,000 to 300,000 mc	Millimetric waves

*Frequencies shall be expressed in kilocycles at and below 30,000 kc and in megacycles above this frequency.

Table II. Proposed Standard Nomenclature

Band Number	Frequency Range (Lower Limit Exclusive, Upper Limit Inclusive)	Metric Subdivision
4	3 to 30 kc	Myriametric waves
5	30 to 300 kc	Kilometric waves
6	300 to 3,000 kc	Hectometric waves
7	3,000 to 30,000 kc	Decametric waves
8	30 to 300 mc	Metric waves
9	300 to 3,000 mc	Decimetric waves
10	3,000 to 30,000 mc	Centrimetric waves
11	30,000 to 300,000 mc	Millimetric waves
12	300,000 to 3,000,000 mc	Decimillimetric waves

Note: "Band N" extends from 0.3×10^N to 3×10^N cycles.

RECOMMENDATION OF THE TECHNICAL SOCIETIES

CO-OPERATIVE EFFORT OVER A PERIOD OF YEARS on the part of the committees of the two engineering societies led to agreement, and recommendations to their respective Standards Committees of a system of band designations based on the powers of ten: the band number to be the exponent of ten corresponding to the lowest frequency of the band.

It will be noted that this recommended system of nomenclature differs from the present standard in that the dividing line between bands is set at powers of ten instead of at three times powers of ten. In addition, the adjectives were replaced by band numbers. Such a system can be extended indefinitely in either direction and should be easily remembered.

INTERNATIONAL ACTION

IT WAS RECOGNIZED that to be completely useful any standard must have world-wide acceptance. Since the standard to be superseded had such acceptance, the Standards Committees, through subcommittees, jointly recommended to the U.S. State Department that the matter be placed on the agenda of the CCIR Plenary Meeting in Geneva, Switzerland, in 1951.

The Geneva meeting referred the question to one of its International Study Groups. The corresponding National Group in the United States included AIEE and IRE members and its recommendation was the proposal agreed to by the technical societies' Standards Committees.

This recommendation, together with those of the United Kingdom, Federal German Republic, Australia, and Italy, was acted upon at the Seventh Plenary Assembly of CCIR in London, England, in 1953. There was unanimous agreement that classification should be by frequencies and not by wavelength. It was further agreed that frequencies should be divided into decade bands, designated in terms of the common logarithm. A proposed system, shown in Table II, which is similar to the recommendation made by the United Kingdom, was unanimously adopted.[5,6]

Although there was support during the discussion for the American proposal, CCIR action favored the plan adopted because, "it is in fair agreement with the criterion of grouping together frequencies with common physical and propagation properties as well as a uniform equipment construction technique." The CCIR recommendation will, undoubtedly, be substituted for the existing standards by ITU action within the next few years.

The table included in the CCIR recommendation has been limited to that part of the spectrum which is generally considered that used in radio transmission. However, the numbering system is such that extensions to either lower or higher frequencies can be made readily. The band numbers are shifted by one from those suggested by the American societies, since they are represented by the exponent of ten corresponding to the upper frequency of the band rather than the lower.

CONCLUSIONS

THE PROPOSED NEW SYSTEM should prove a good compromise of the recommendations submitted. It includes sufficient flexibility to permit the specific standardization of extensions of the system from either of the limits shown by the CCIR. It would appear to meet many of the objectives of those who have been working for an improved system. It has simplicity, ease of remembrance, capability of expansion, and is potentially useful to all technical fields.

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Quadriphase—A New Approach to Time-Division Multiplexing

W. E. EVANS R. F. LOWE
ASSOCIATE MEMBER AIEE

Time-division multiplex systems once required either complex waveforms or multiple complex networks to overcome the master timing or synchronization problem. Now this newly designed quadriphase system, using a completely new approach to the problem, presents simplicity of design, operation, and maintenance, with similar reliability and excellent performance.

THE COMMERCIAL microwave communication industry has supported a more or less continuous controversy on the pros and cons of time-division vs. frequency-division multiplexing. One of the conclusions which can be drawn from these discussions is that time division has certain theoretical advantages; that is, whenever a multichannel communication system is pushed to its ultimate performance by the length of the system, or by simultaneous and continuous loading of a high percentage of the channels, time-division multiplexing can produce higher signal-to-noise ratio and lower crosstalk.

However, the master timing or synchronization of a time-division multiplex system has presented many practical problems. Generally, this master timing has required either complex waveforms such as the sawtooth or a sharp "timer pip" spike, or multiple complex networks to delay a master pulse waveform by various amounts. Most time-division synchronizing systems have required very precise and very stable plate and bias voltages. Until now, it has been found that excellent design, top-quality components, regulated power supplies, and good maintenance were required to achieve the theoretical advantages of time-division multiplexing.

A NEW CONCEPT OF SYNCHRONIZATION

TO OVERCOME these practical drawbacks, a completely new approach to the synchronization problem has been taken. In the conception of the quadriphase system, simplicity of design, operation, and maintenance has been a

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W. E. Evans and R. F. Lowe are with the General Electric Company, Syracuse, N. Y.

The authors wish to acknowledge the development of the original concept of the quadriphase system by H. P. Thomas and P. G. Smee of the General Electric Company, Syracuse, N. Y.

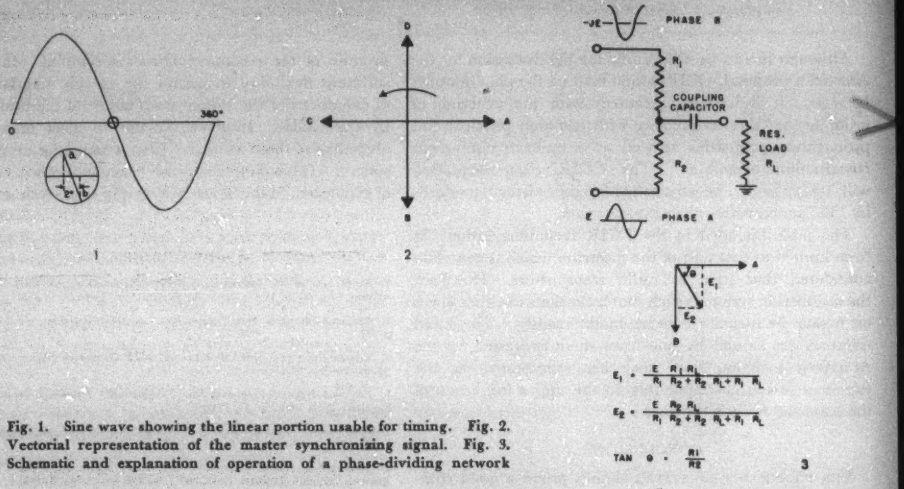

Fig. 1. Sine wave showing the linear portion usable for timing. Fig. 2. Vectorial representation of the master synchronizing signal. Fig. 3. Schematic and explanation of operation of a phase-dividing network

prime requisite. The designers were faced with two questions:

1. What is the most simple waveform—the easiest to generate and to carry from the master generator to several slave units?
2. What component is the simplest, the least expensive, and the most trouble-free?

The answers to these two questions are really quite obvious. The simplest waveform is a low-frequency sine wave; the most elementary component is the resistor. These two—sine and resistor—form the heart of the quadriphase system.

The sine wave is not generally considered as a good timing signal because of its wide variations in slope. However, the portion of a sine wave in the immediate vicinity of the zero axis is very linear and can be used as an accurate time base.

The segment *a-b* of Fig. 1 is the part of the sine wave which has a slope that is steep enough and linear enough to be used as an accurate timing signal. The remaining problem is to make use of only the linear portion. In order to accomplish this, the phase of the sine wave must be shifted by finite increments through 360 electrical degrees. More precisely, the phase of the master sine wave must be shifted so that its zero point at which the voltage is going from negative to positive will occur at the beginning of the time space allocated to each channel of a multichannel system. It is neither practical nor in keeping with the simplicity requirements to achieve this by employing a completely different phase-shifting network for each channel.

A single sine wave can readily be made into two such waves phased exactly 180° apart by a conventional paraphase amplifier or phase inverter. If each of these two waves is shifted 90° by a stable temperature-compensated resistance-capacitance network, then four sine waves are made of exactly the same frequency and phased in quadrature, i.e., quadriphased. These may be represented in vector form as shown in Fig. 2.

With these four sine waves as a master timing signal, it is possible to use networks containing only resistors to form a sine wave of any desired phase. This is illustrated in Fig. 3 which shows two resistors connected in series from phase *A* to phase *B*. The voltage developed across the load is a sine wave whose phase is dependent upon the relative value of the two resistors. It is shown in Fig. 3 that the output phase of the divider is completely independent of loading as long as the load is resistive; thus giving a "phase divider." With this simple type of device it is possible to produce a sine wave of any desired phase.

Only a very small portion of the sine wave in the immediate vicinity of the zero axis (much less than the total linear portion indicated in Fig. 1) will be used for the actual timing of the channel pulses. Therefore, the amplitude of the quadriphase voltages is not a critical factor; regulated plate voltage is not required in any part of the quadriphase system.

SYSTEM DESIGN CONSIDERATIONS

THE FREQUENCY chosen for the master sine waves will be equal to the frame repetition rate, which is the sampling rate for each channel. In order to keep audio distortion low, it is desirable to have the sampling rate approximately three times the maximum audio frequency to be transmitted. Using this criterion, the frame rate and thus the oscillator frequency must be in the range from 8 to 10 kc for telephone voice channels which normally have a bandwidth of about 300 to 3,000 cycles per second (cps). If the time allocated to each channel is chosen at 4 microseconds (μsec), and if a like time is provided for the marker and for the guard space on either side of the marker, a 25-channel system requires a total of 28 intervals of 4 μsec, or 112 μsec per frame. Fig. 4 shows one frame of the composite multiplex signal for such a system using pulse-position modulation. This frame period results in an oscillator frequency of 8,929 cps.

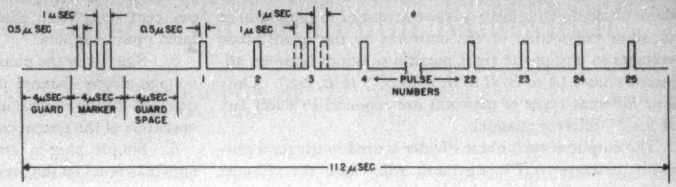

Fig. 4. One frame of the composite multiplexing signal showing pulse number 3 modulated 100 per cent

TRANSMITTING SECTION

Master Synchronizing Generator. Fig. 5 is a block diagram of the master synchronizing generator. The tuned plate circuit of the master oscillator employs a torroidal coil with a Q of approximately 200 assuring excellent frequency stability. Negative feedback is employed for amplitude stability. The output of the oscillator drives a paraphase amplifier to produce two waves of equal amplitude and frequency, but opposite phase, (vectors A and C of Fig. 2). Vectors B and D of Fig. 2 are obtained by 90° phase shift from vectors A and C. Each of the four phases is fed through a cathode follower having an effective output impedance of approximately 10 ohms. These four cathode followers are arranged as two push-pull pairs. The output voltages from these cathode followers are in the order of 35 volts rms.

Marker Pulse Generator. In order to form a marker pulse, a phase divider is connected from phase A to phase D. The resultant voltage is used to trigger a gate generator. This gate turns on a 1-mc oscillator for 3 cycles. These three cycles are rectified and clipped to form three 1/2-μsec pulses located in time, immediately prior to phase A, as shown in Fig. 4.

Channel Pulse Generator and Modulator. The four voltages generated by the master synchronizing generator are fed to the phase divider network associated with each channel-pulse generator. Electrically, these networks have a negligible loading effect upon the quadriphase voltages since the phase dividers have an impedance of approximately 30,000 ohms and the quadriphase-voltage generator has an effective 10-ohm driving impedance. Physically,

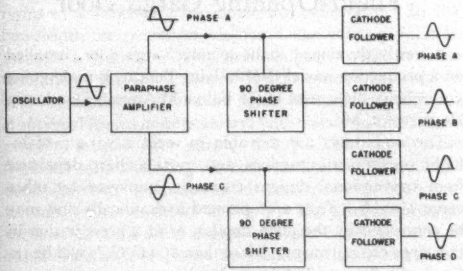

Fig. 5. Master synchronizing generator

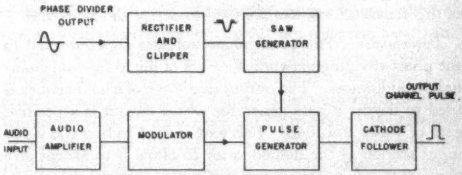

Fig. 6. Channel pulse generator and modulator

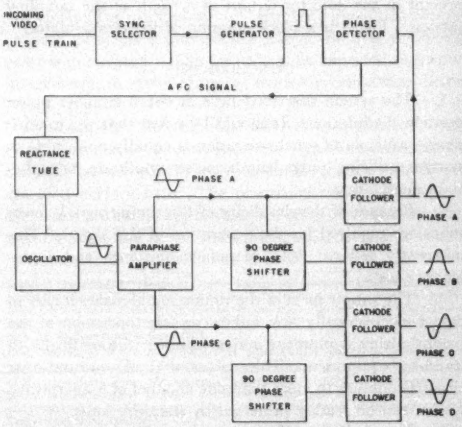

Fig. 7. Receiving synchronizing generator

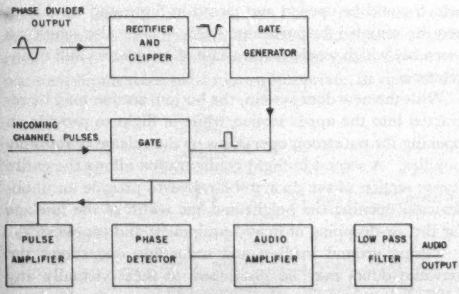

Fig. 8. Demodulator

these phase-dividing networks are arranged to plug in so as to allow connection of the networks to the quadriphase voltages in any of the eight possible positions between adjacent phases (*A* to *B*, *B* to *A*, *B* to *C*, *C* to *B*, etc.). Only four different types of networks are required to select any of the 25 different channels.

The output of each phase divider is used to trigger a sawtooth generator. The sawtooth will cause the channel pulse to be generated at the mid-point of the 4-μsec time space allocated to that particular channel. The presence of an audio-modulating signal causes the channel pulse to be formed earlier or later during this time space. Maximum deviation from the center position is limited to ± 1.1 μsec. Nominal 100-per-cent modulation is ± 1 μsec. A block diagram of the modulator is shown in Fig. 6.

RECEIVING SECTION

Receiving Synchronizing Generator. The receiving synchronizing equipment as shown in Fig. 7 contains an oscillator, paraphase amplifier, and cathode followers similar to the transmitting equipment to generate the quadriphase voltages. The oscillator, however, is controlled by an automatic-frequency-control (afc) circuit and reactance tube to maintain synchronism of the quadriphase voltages with the received pulse train. A marker selector is employed to detect the marker pulse (by virtue of its makeup of three 1/2-μsec pulses closely spaced). The recurrence rate and the phase of this separated marker are used to derive the afc signal.

Demodulator. The quadriphase voltages are connected to the phase-dividing networks for each of the individual channel demodulators. The output sine wave of each network is used to trigger a gate generator whose output is a positive gate of 4-μsec duration. This gate is used to bias the video input section of the demodulator to allow it to accept any channel pulse occurring during the gate interval, but to reject all others. The modulation on the channel pulse is detected by means of a balanced phase detector. A low-pass filter is used to remove any high-frequency components present in the detector output as a result of the sampling process. Fig. 8 is a block diagram of the demodulator.

CONCLUSIONS

1. The system described here in detail employs pulse-position modulation. It should be noted that the quadriphase principle of synchronization is equally applicable to systems utilizing pulse length, pulse amplitude, or pulse-code modulation.

2. Because of the simplicity of the timing signal, fewer tubes are required for the generation of this signal. This inherently reduces both manufacturing cost and maintenance costs.

3. The simple form of the timing signal makes it easy to detect electronically any failure or false operation of the synchronizing equipment and to transfer automatically to stand-by equipment. This means that all vacuum-tube circuits common to more than one channel of a microwave system can be readily protected by stand-by units.

4. The negligible effect upon channel-pulse positioning of plate-voltage variations of as much as 10 per cent to 15 per cent completely eliminates the requirement for regulated power supplies.

5. Since only the phase and not the amplitude of timing voltage affects channel pulse position, tube aging can be detected during routine maintenance long before any faulty operation of the system occurs.

6. Simple plug-in arrangement of the phase-dividing networks provides the utmost in flexibility in changing channel assignment of a particular facility when rearranging system channel layout or when expanding an existing system.

7. Eight-position plug-in feature of phase-dividing networks results in only four different networks for a complete 25-channel system. These networks are comparable in function to the channel band-pass filters of a frequency-division system, but each consists of only two resistors instead of a number of inductances and capacitors.

8. A time-division multiplex system using the quadriphase system for channel timing is simpler to maintain, has fewer tubes, and is affected less by line-voltage variations than any previous time-division system. It is more than adequate to meet today's high standards for microwave-system performance and reliability.

Flight-Opening Cargo Door

A newly developed flight-opening cargo door, installed on a production model *C-119* Flying Boxcar, is undergoing preliminary flight tests at the Fairchild Aircraft Division in Hagerstown, Md.

The new doors are movable to meet a variety of in-flight operational situations and mark a sharp departure from conventional designs currently employed by other cargo aircraft. They are operated hydraulically and may be controlled by the pilot, copilot, or at a crew station in the cargo compartment. More than 100 *C-119*'s will be refitted with the new flight-operable doors.

Lessons learned in the Berlin, Korean, and Indo-China airlifts have been applied in developing the unique unit. While the clam-shell doors on production model *C-119*'s have proved invaluable for many of the Armed Forces' operational tasks, Fairchild worked for a cargo door system which could be opened and closed in flight and would not require removal for parachute drops. They also sought an assembly which would feature ease of production and maintenance.

With the new door system, the bottom section may be retracted into the upper section while in flight to provide an opening for paratroop operations or the release of resupply bundles. A second in-flight configuration allows the entire upper section of the door to be raised to provide an unobstructed opening the height and the width of the fuselage for the air-dropping of heavy equipment and supplies.

During ground loading and unloading operations, the versatile doors may be positioned to meet virtually any loading situation. In all cases, regular cargo-handling systems may be used.

Control-System Design for Minimum Bandwidth

G. C. NEWTON, JR.
MEMBER AIEE

THIS digest discusses a method of designing feedback control systems so that for a specified performance their bandwidth is a minimum. Not infrequently, engineers have designed control systems with the objective of minimizing errors; with attention focused on the problem of minimizing errors there is a tendency to use bandwidth inefficiently so that he manufactures increased difficulties. He may open up the bandwidth of the control system to the point where he has undue transmission of noise. In the case of mechanical systems, he may increase the bandwidth to the point where elastances in gear boxes and supporting structure will cause severe stability problems. As the result of large bandwidth, he may encounter a saturation problem in one of the components toward the output end that would not otherwise exist. Expanding the bandwidth of a control system may require him to use more expensive components than are really necessary. For these and many other reasons he should strive to keep the bandwidth requirements of a feedback control system as low as possible.

This digest defines the bandwidth of a control system in terms of a procedure for measuring bandwidth. In the bandwidth test procedure employed, the noise transmitted through a "standard" system is compared with the noise transmitted through a control system whose bandwidth is to be determined. The noise signal for the bandwidth test is obtained from a noise generator with characteristics appropriate to the particular purpose at hand. The output noise from the standard system is compared with that from the control system by means of an rms indicator connected through a filter as shown in Fig. 1. The filter permits the designer to have some degree of control over the rate of cutoff of the control system. By definition, the control system is said to have the same bandwidth as the standard system when the rms noise transmitted through it is equal to that transmitted through the standard system.

After defining bandwidth, the next question to face in connection with the development of the design procedure discussed here is the nature of the input signals. To illustrate the general approach we have considered the input signal to be transient in form. Stochastic signals could have been equally well considered. However, transient inputs seem to be more appropriate, in view of the somewhat simpler problem statement they make possible, and in view of the number of instances in which practical specifications can be translated into one or a few transient tests.

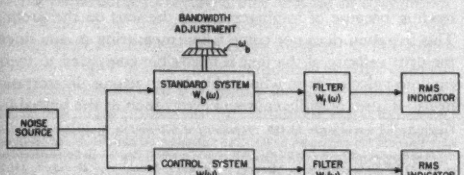

Fig. 1. Scheme for defining system bandwidth

Next the engineer must select a suitable performance index. Of the various indexes possible such as build-up time, settling time, peak error, integral time, absolute error, integral-square error, etc., we have chosen integral-square error as the performance index. This is done primarily for reasons of analytical convenience, but is is shown that integral-square error is a reasonable performance index when minimizing bandwidth.

The problem can now be stated very specifically: Find the control-system characteristic which minimizes the bandwidth while maintaining the integral-square error for a transient input signal equal to or below a specified value. There are no preconceived notions as to the form of the control system other than the assumption of linearity. (The assumption of linearity is almost implicit in the concept of bandwidth.) The engineer shows that the practical problem of designing a minimum-bandwidth system is equivalent to the mathematical problem of selecting a system weighting function which will minimize the rms noise transmitted through the system without causing the integral-square error to exceed a specified value. The mathematical problem turns out to be an isoperimetric problem in the calculus of variations. A general solution to this problem is found in the form of an integral equation. This solution is illustrated by two examples which show the effect of increased rate of cutoff on the bandwidth required for specified peak errors. Also, by means of another example, in which the peak error is used as the performance index, we find that minimizing the integral-square error for a given bandwidth yields a peak error only slightly larger than if the peak error is minimized. This result is to be expected since the integral-square error criterion tends to emphasize large errors.

In conclusion, the engineer observes that practical considerations may frequently interfere with the realization of control systems which truly minimize bandwidth for a specified performance. The procedures discussed, even if they are not directly applicable, will often serve the designer well by providing bench marks or standards against which he can assess his detailed design arrived at by trial-and-error.

Digest of paper 55-194, "Design of Control Systems for Minimum Bandwidth," recommended by the AIEE Committee on Feedback Control Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Scheduled for publication in AIEE *Applications and Industry*, 1955.

G. C. Newton, Jr. is with the Massachusetts Institute of Technology, Cambridge, Mass.

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The author wishes to acknowledge the constructive suggestions made by his colleagues in the Servomechanisms Laboratory, and especially those made by Dr. L. A. Gould and Dr. J. C. Simons.

Measuring and Recording Atmospheric Electrostatic Potential

J. S. CARROLL
FELLOW AIEE

S. B. HAMMOND
ASSOCIATE MEMBER AIEE

E. H. STEWART
ASSOCIATE MEMBER AIEE

An electrostatic voltmeter designed to record potentials as low as 1 volt direct current with an input resistance of 10^{14} ohms is described. It uses an electrostatic generator to provide an a-c signal proportional to voltage, together with a simple audio amplifier which requires only a commercial 1-milliampere recording meter as auxiliary equipment.

MEASUREMENT OF ATMOSPHERIC electrostatic potentials has intrigued scientists and engineers for many years. Benjamin Franklin's lightning experiments proved the existence of an atmospheric electrostatic potential with the crude instruments available in his day, and later work with more refined instruments has indicated that these potentials range from very low values to several thousand volts. The principal difficulty encountered in measuring these potentials has been similar to the essential problem of many other types of electric instrumentation; namely, the power required to operate the instrument distorts the potential thereby measured. The instrument reading, therefore, is not the desired potential but something different which must be corrected in order to obtain the true value. This problem is very difficult when measuring atmospheric electrostatic potential because of the extremely small amount of power available to drive the measuring instrument. This power limitation requires extremely high input resistance. The development of electroscopes and other instruments with input resistance of 10^{12} ohms and higher has been necessary in order to obtain reasonably reliable measurements. Carroll and Hammond[1] present a discussion of this problem while describing an instrument suitable for taking these readings, but not suitable for continuous recording without an operator.

The instrument to be described consists of a radioactive probe which measures the atmospheric electrostatic potential, a rotating capacitor which converts the d-c signal from the probe to an a-c signal, an amplifier to amplify this signal, and a recording meter to record it. These basic parts are shown in Fig. 1. The important requirements specified were

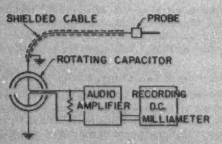

Fig. 1. Functional diagram: rotary electrostatic voltmeter

1. Instrument must be reliable, portable, and maintain calibration, using commercially available components as much as possible.
2. Leakage current must be low.
3. Recording and indicating must be done on standard 1-milliampere d-c instruments.
4. Equipment must be capable of operation by people not especially trained in electrical measurement technique.

THE PROBE

MEASUREMENT OF ELECTROSTATIC POTENTIAL is usually accomplished by using a well-insulated probe which can assume the potential of the surrounding atmosphere. The probe in turn is connected to a voltage-measuring device. A simple needle-point probe could be used if it were well enough insulated, but its reponse would be slow. To give quicker response, and with less meticulous insulation, the historic flame or water-drop probe could be used, but they are relatively cumbersome. In order to obtain rapid response while retaining a convenient configuration, a radioactive probe was initially used for this instrument. This is a needle probe, see Fig. 2, which is made radioactive by wrapping a piece of polonium foil around most of the needle. The preparation of this foil was similar to the preparation described by Martin.[2] The polonium is an alpha emitter and provides a region of highly ionized air around the probe with a maximum diameter of approximately 8 cm. The presence of this conducting region permits rapid equalization of any potential difference that may exist between the probe and the surrounding atmosphere, and permits rapid response to changes in potential. The conducting region should not distort the electrostatic field (provided the field is relatively large) because of the balance of charges of the ions generated. Further work is being done on the effects of probe configuration and variations of radioactivity.

Theoretically there are several possible causes of a discrepancy between probe voltage and the voltage in the surrounding medium. Probably the best known of these arises from the drift velocity of ions (as differentiated from their random kinetic velocity), and this has caused considerable difficulty in the use of probes in partially evacuated tubes. In the case of these gas tubes, appreciable ion velocities can be attained and this ion stream will distort the probe reading because of impingement of the ions on the probe. This situation does not come when measuring in air, since the drift velocity of the ions is negligible compared to their random velocity, even when subjected to strong electrostatic fields. Other possible causes of error, such as the probabil-

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J. S. Carroll is with Stanford University, Stanford, Calif.; S. B. Hammond is with the University of Utah, Salt Lake City, Utah; E. H. Stewart is with the Westx Electric Heater Company, San Francisco, Calif.

ity of more ions of the predominant polarity impinging by random kinetic velocity on the probe and the effect of the work function of the surface of the probe, are also negligible when using the probe in the ambient atmosphere and measuring potentials of a volt or greater.

A probe used to measure atmospheric potential must be used to give minimum distortion of the electrostatic field which exists in the absence of the probe. It is necessary to use a shielded conductor from the probe to the measuring instrument since it is desirable to separate the measuring instrument from the probe by several feet to minimize the field distortion by the instrument case. To accomplish this, a length of coaxial cable was slipped inside a 6-foot length of polystyrene tube. The shield was terminated and left unconnected inside the tube about an inch from the probe and was grounded to the instrument at the terminal end. The shielding provided by the cable effectively prevented pickup of random electrostatic or electromagnetic fields by the lead wire and permitted considerable separation between the probe and the measuring instrument. The two limitations on the length of the cable are, first, the decreasing input resistance of the measuring instrument as seen by the probe as additional cable is added, and, second, the slower response to change in potential which follows from the increase in capacitance with increase in cable length. The authors used a commercially available cable approximately 10 feet long terminated by a commercially available plug with good success.

To restrain the grounded shield of the cable from distorting the electrostatic field, the cable was passed from the probe through the polystyrene tube until well removed from the field being measured. The tube also served to support the probe, providing an excellent insulating support.

At the moment of initial insertion of the probe into the existing field, distortion of the field unquestionably takes place. As the charge on the probe builds up, there is a small current flow along the outer surface of the polystyrene tube since this tube is a path to ground from the probe. The outer surface of the tube also attracts free ions from the atmosphere until each point along the surface of the tube is at the potential which that point in space had achieved before the probe was inserted into the field. When this equilibrium of charge is achieved, the electrostatic field is no longer distorted. In the ideal case where no current is drawn, this equalization would be perfect. In this instrument the impedance to ground measured at the probe is approximately 10^{14} ohms and for the measurement taken by the authors it was considered that no appreciable distortion of the field took place.

One other point to be taken into account in considering field distortion is the size of the probe in relation to the voltage gradient and the field being measured. The probe shown in Fig. 2 is small when compared to most outdoor fields, and can be used successfully for many indoor measurements. This probe must be considered as a conducting cylinder 3 cm long and 8 cm in diameter. The large diameter is the ionized zone, which is sufficiently conducting to be an equipotential volume, and its radius is the radius of the probe plus the range in air of the alpha radiation from the foil (about 3.8 cm).

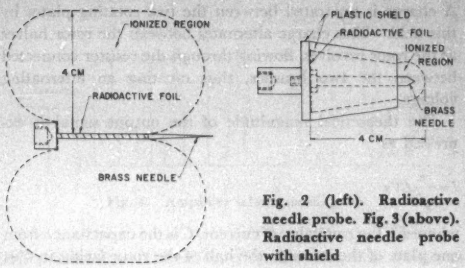

Fig. 2 (left). Radioactive needle probe. Fig. 3 (above). Radioactive needle probe with shield

In a small enclosure, a probe as large as this distorts the field too much, and a modified design is shown in Fig. 3. The plastic shield in this design stops all radiation except that aimed at a small volume close to the point of the probe. The conducting volume is a cylinder approximately 1/2 inch in diameter and 1/2 inch long, making it possible to use this probe in much smaller rooms than was possible with the probe of Fig. 2. The plastic shield serves to minimize field distortion by accumulating a charge in the same way the polystyrene tubing shields the coaxial cable.

ROTATING CAPACITOR

THE ROTATING CAPACITOR is basically a type of electrostatic generator, connected to deliver alternating current instead of the more usual direct current. Kirkpatrick[3–6] was successful in developing this principle to measure the high target voltages used on X-ray tubes when conventional instruments of that time required more power than was available.

Physically, this portion of the instrument, shown in Fig. 4, consists of two concentric brass cylinders approximately 2 inches in diameter and 4 inches long, with about 1/16 inch separating the inner and outer cylinders. Both cylinders are split lengthwise, and the two halves are well insulated from each other. The inner cylinder halves are mounted on a shaft, but insulated from it, free to rotate inside the fixed outer cylinder halves. The inner half-cylinders are connected to slip rings, which in turn make contact with brushes connected to the amplifier. The rotor part is driven by a synchronous-type motor operating at 1,200 rpm.

In operation, the probe is connected to one fixed plate, while the other plate of the stator is grounded, thus establishing an electrostatic field between the two fixed plates.

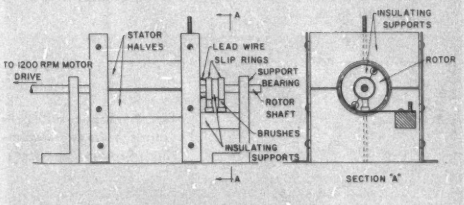

Fig. 4. Rotating capacitor

A charge is separated between the two rotating plates by this field. This charge alternates between the rotor halves as the rotor revolves, flowing through the resistor connected between the two brushes, thus creating an alternating voltage.

The theoretical magnitude of the output signal is expressed as

$$I = \frac{\pi}{\sqrt{2}} CVn$$

where I is the rms value of current, C is the capacitance from one plate of the stator to the half of the rotor facing it, V is the voltage applied to the plates of the stator, and N is the speed of the rotor in revolutions per second. The derivation of the constant $\pi/\sqrt{2}$ in this equation is based on the assumption that the variation of capacitance as the device rotates is sinusoidal, and the impedance in the instrument circuit through which current flows is small when compared to the impedance between the rotor half and the stator half which it is facing. Note that the power to supply the output signal is supplied by the drive motor, and therefore this instrument draws no power from the room or device under test except for leakage current through 10^{14} ohms.

In practice this instrument can be calibrated by applying a known d-c potential to the stator of the rotating capacitor and observing the corresponding deflection of the milliammeter. Therefore, the exact waveshape of current output to the amplifier and its absolute magnitude are not of vital importance and the fact that the two foregoing assumptions are only approximately correct does not affect the over-all accuracy of the instrument.

It is obviously desirable to make I as large as possible in order to obtain the largest possible voltage across the load resistor. This requires the largest possible value for C, as well as a high rotational speed for the motor. However, the larger C is made, the slower will be the response to a change in voltage, unless the effective resistance of the probe is decreased by increasing the radioactivity. In the instrument built by the authors, C was of the order of 50 micromicrofarads, the exact value depending on the spacing between the rotor and stator, which was varied during the course of experimentation. The resulting time constant with probe and cable was approximately 1 minute, which was satisfactory.

With fixed C and n, output current and voltage are directly proportional to applied voltage, as shown in Fig. 5. The output voltage, rms reading of 20-cycle-per-second (cps) signal, ranged from 0.6 to 1.0 per cent of the applied direct voltage, depending on the spacing between rotor and stator, so that a 10-volt potential on the stator supplied 60 to 100 millivolts at the brushes.

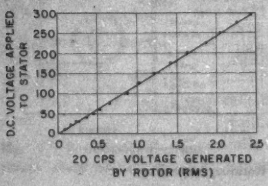

Fig. 5. Input voltage—output voltage relationship of rotary capacitor

Early measurements were made with a motor operating at 3,400 rpm, and these measurements demonstrated the expected increase in output voltage with increased speed when compared with the 1,200-rpm motor. However, use of a frequency so close to line frequency demonstrated the problem of interference due to stray field pickup, and a deliberate attempt was made to use a frequency quite different from the line frequency, thus permitting compensation for any line signal pickup, either in the probe or later in the circuit.

THE AMPLIFIER

THE OUTPUT OF THE ROTATING CAPACITOR must be connected to a high-input-impedance vacuum-tube voltmeter in order that the small current will develop as large a voltage as possible. The original calibration of the rotating capacitor was performed using a commercially available instrument with an input resistance of 10 megohms. The amplifier circuit that was constructed to work with this capacitor is shown in Fig. 6 and examination of the circuit shows that it is a more or less conventional audio amplifier. A high input impedance was provided by using a free-grid cathode-follower input[6] and a low output impedance to match standard 1-milliampere d-c recording instruments was obtained by again using a cathode follower in an electrometer-type output circuit. The amplifier was calibrated so that a direct voltage of 10 volts applied to the probe will drive a 1-milliampere meter to full scale. Analysis of this circuit shows that increased sensitivity would not be difficult to achieve if it were required, since this amplifier requires approximately 100 millivolts of 20-cps signal for full-scale deflection of the meter. This sensitivity is satisfactory for presently contemplated measurements.

In meeting the fourth requirement cited earlier, namely, that the equipment must be capable of operation by people not especially trained in electrical measurement techniques, an attempt was made to keep the amplifier design as simple as possible. Feedback was, therefore, not used in this design and provision was made for simple calibration checks and recalibration if necessary (although these details are not shown in the schematic drawings). The possibility of drift in the amplifier was recognized and further experience may prove the necessity of utilizing a feedback type of design, in spite of the greater complication, although experience to date indicates that the amplifier design shown herein is sufficiently stable to allow operation by untrained people.

APPLICATIONS

THIS INSTRUMENT WAS DESIGNED for measurement and recording of atmospheric electrostatic potential as a means for determining the number of atmospheric ions present in a given environment. Although designed primarily for indoor use, it can be used outdoors if the probe is properly shielded. In this connection it is important to keep in mind that this instrument does not measure air ionization directly but measures instead the electrostatic potential from which the net ion density can be calculated. The method of calculation has been investigated and a simplified procedure is being prepared by S. B. Hammond for later publication.

There appear to be two important limitations to be kept

in mind using this instrument for measuring of atmospheric electrostatic potential. First, this instrument measures the total potential at a point regardless of the source of that potential. This means that stray electrostatic fields must be eliminated or must at least be known so that the instrument readings can be corrected. In many cases this presents no serious problem, since frequently no stray electrostatic field is present, but in other situations careful examination of the readings is required. An example of this problem was observed by the authors when a recording was made with the unshielded probe outdoors, about 7 feet above ground, during a period of stormy weather. Potentials recorded varied from a few volts to several hundred volts, apparently in response to passage of clouds overhead.

Second, the use of electrostatic potential to determine ion density is complicated by the fact that only the difference in concentration between positive and negative ions can be measured and it is not possible to measure the total number of ions of each sign that may be present. Other types of instruments have been developed which measure ions of each polarity separately and one instrument is particularly well described by Fleming.[7] These instruments deplete the number of ions in the air and therefore in many circumstances do not give an accurate indication of the number of ions present in the absence of the instrument. This is in contrast with the instrument described in this article which does not deplete the ions present in the atmosphere. Correlation of readings of these two types of instruments may be necessary in certain types of problems but where only the net ion density is required or where the information desired is atmospheric potential only, this instrument appears to have many possibilities of application.

Measurement of air ion density has been attempted for many years in conjunction with investigations of the effects of natural and artificial air ionization on humans and animals. Martin[8] summarizes much of the early investigation while discussing one means of artificially producing air ions. Skilling and Beckett[9] discuss other types of ion generators. Murphy[10] discusses the problem of unnatural ion balance from the viewpoint of the air-conditioning engineer. The

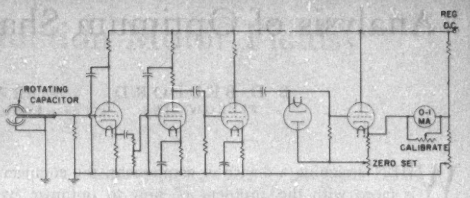

Fig. 6. Amplifier schematic diagram

instrument described herein is readily adaptable for use in testing the air ion density in ventilation ducts and rooms.

This instrument was devised as a means of measuring air ion density, since ion density can be calculated if the potential due to the ions is known, together with room dimensions. Other possible applications include measurement of space charge where static accumulations present problems, and more general use as a d-c voltmeter having extremely high input impedance. The basic principles are well established and adaptable to many applications, while the resulting instrument is simple and reliable.

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ERA-1130 Digital Computer to Solve Aircraft and Missile Problems

Newest of the "electronic brain" computers employed by Convair Division of General Dynamics Corporation to speed engineering and development of advanced aircraft and missiles is this Remington-Rand ERA-*1130* UNIVAC scientific digital computer. Ben Ferber, Convair's digital computer laboratory supervisor, watches the flashing lights on the computer's console as a problem is worked electronically by the computer. The factors for a problem, such as calculating the forces applied to the delta wing of a Convair *F-102A* all-weather interceptor during a supersonic turn, are fed into the machine on punched cards, on the right in the foreground, and the answer is produced on other punched cards and an electric typewriter. The computer can remember 17,408 sets of figures at one time.

Analysis of Optimum Shape for Magnetic Amplifiers

B. D. BEDFORD
FELLOW AIEE

C. H. WILLIS
FELLOW AIEE

G. C. DODSON
ASSOCIATE MEMBER AIEE

WHEN designing a device or component, the engineer is faced with the problem of how to optimize its shape to make the best use of the materials.

One method, which is referred to as "application of infinitesimal per-unit increments," is really a cut-and-try process. It is useful in designing many things and has been successfully applied to transformers, fluorescent-lamp ballasts, and magnetic-amplifier reactors. Though most easily illustrated in simple problems, its real merit is found in complex problems difficult to solve mathematically.

Based on the principles of differentials and generalized linear-dimension relationships, the method depends upon a simple straightforward criterion of optimization.

Consider its application to optimizing the shape of a cylinder where the maximum enclosed volume for a fixed amount of sheet metal is sought. Note first, maximum volume V is sought for a fixed surface A—not simply maximum V/A, where either diameter D or height H is held fixed while the other is varied. This produces no maximum. Similarly, V/A increases continuously when any shape is simply scaled up, because volume is responsive to the third power of linear dimension, and surface the second power.

Infinitesimal per-unit (pu) increments simplify calculations in the foregoing step. Simple additions of increments rather than complex multiplications can be employed. If every dimension is increased by 1-pu increment, volume increases by 3-pu increments and surface by 2. Also, the method simplifies optimization by its independence of holding one quantity fixed while seeking a maximum or minimum of the other.

A rule is: "If the device has optimum shape, the ratio between the resulting pu increments in optimizing characteristics (V and A) is equal to the ratio between exponents or powers of linear dimension for these characteristics (3 and 2)."

The five steps in the application of the method are: (1) identify the two characteristics used to determine the optimum, e.g., volume and area; (2) determine the power of linear dimension to which the optimizing characteristics are responsive; (3) assume a reasonable shape, subject it to increments, and apply the criterion, tabulating the results; (4) reproportion shape based on results of (3) and repeat; and (5) systematically continue (4) quickly to reach optimum.

As in any analysis, appropriate labor-saving assumptions must be made without jeopardizing accuracy of results. Also, the extent of the analysis must be defined. For magnetic-amplifier reactors, it was decided that there are two significant cases deserving first attention: (1) thermally limited reactor, and (2) resistance-limited reactor.

The thermally limited case applies to large reactors where delivery of controlled power overshadows the amplication function. Economically, power efficiency is important. The optimized reactor delivers a maximum of power for a minimum of materials cost. It was therefore assumed that logical heat-dissipating surfaces of the reactor were run at the maximum temperature possible and that losses in the reactor were a very small part of power delivered. The analysis was limited to reactors with 2.5 per cent or less losses—roughly reactors rated 10 kw and larger, as shown by the calculations. The proportions of the optimized half-wave reactor are shown in Fig. 1*a*.

The resistance-limited case applies to small reactors where performance overshadows power efficiency. The optimized reactor yields a maximum d-c gain for a minimum of time constant. In this size range, load resistance is matched to reactor gate winding resistance for maximum power transfer without thought to efficiency. Inherently, in this range, the current density in the copper is below the level where heat-dissipating surfaces will be run at maximum permissible temperatures. The analysis indicated the range to be for reactors rated 5 volt-amperes (va) and below for punched cores, and 3 va and below for toroids. The optimized configurations are shown in Figs. 1*b* and 1*c*.

In the range between 5 va and 10 kw, an appropriate compromise can be made by the designer, weighing his configuration toward the case more closely related to his application. The great value of the explicit shapes evolved is in directing the designer's judgment rather than giving him exact proportions for his reactor.

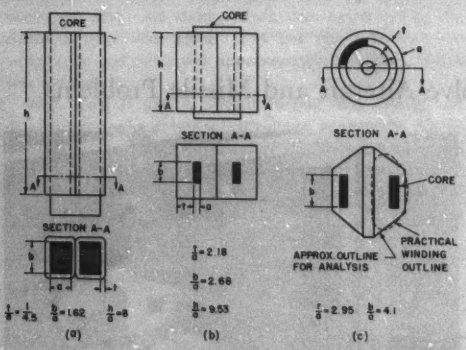

Fig. 1. Results of magnetic-amplifier reactor optimization

a—Thermally limited reactor, 10 kw and larger; b—Resistance-limited reactor, 5 volt-amperes and smaller; c—Resistance-limited reactor, 3 volt-amperes and smaller

Digest of paper 55-68, "An Analysis of Optimum Core Configuration for Magnetic Amplifiers Using a Simplified Approach," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31-February 4, 1955. Scheduled for publication in AIEE *Communication and Electronics*, 1955.

B. D. Bedford and G. C. Dodson are with General Electric Company, Schenectady, N. Y.; C. H. Willis is with Princeton University, Princeton, N. J.

Effect of Skew on Induction Motor Fields

C. E. LINKOUS
ASSOCIATE MEMBER AIEE

INDUCTION-MOTOR designers have recognized for many years that the skew of the rotor slots with respect to the stator slots produces variations axially across the stack in the net fundamental mmf wave. This variation affects the saturation factors, iron losses, and motor noise.

In a balanced polyphase motor, the rotating sine wave of net mmf remains constant in amplitude for a particular axial plane (a plane parallel to the plane of the laminations), and constant in angular velocity. However, in an unbalanced polyphase induction motor or a single-phase induction motor, the net mmf wave varies in amplitude and angular velocity as it rotates; the amplitude in elliptical manner, and the velocity with a double frequency component.

What the designer needs to know is the maximum net mmf experienced across the air gap at any particular angular location on the stator bore. Except in the case of a balanced-polyphase motor, this is in general not the same as the amplitude of the net mmf wave as the peak of the waves passes the location in question. The locus of the maximum net mmf across the air gap, plotted on polar coordinates with the angle in electrical degrees, lies in the region between an ellipse and a circle which has the same diameter as the major diameter of the ellipse. See Fig. 1.

For Fig. 1, the parameter M is defined as

$$M = \frac{P-N}{P+N}$$

where

P = amplitude of the forward flux density wave.
N = amplitude of the backward flux density wave.
B_{max} = maximum flux density that a particular angular location experiences.

The ellipses associated with these curves have their major axes along the vertical. Where the ellipses and the curves of Fig. 1 cross the major and minor axes, the curves are tangent to each other. Note that the circle for $M=1$ corresponds to the absence of a backward field, and the two tangent circles correspond to $M=0$, the other extreme, where the backward field is equal to the forward field.

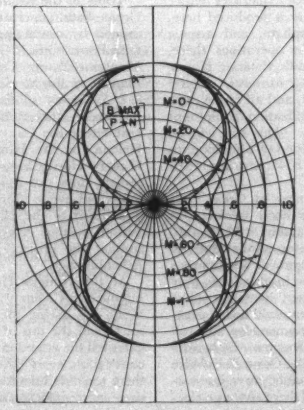

Fig. 1. Normalized curves for determining the maximum magnetic induction

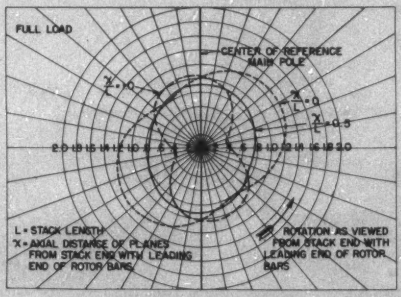
FULL LOAD
CENTER OF REFERENCE MAIN POLE
L = STACK LENGTH
X = AXIAL DISTANCE OF PLANES FROM STACK END WITH LEADING END OF ROTOR BARS
ROTATION AS VIEWED FROM STACK END WITH LEADING END OF ROTOR BARS

Fig. 2. Maximum mmf vs. angular position for three axial planes at full load

The transformer equivalent circuit can be used to determine the forward and backward stator and rotor current fields at the middle of the stack. The net mmf is proportional to the vector difference in these currents. For net mmf at other axial locations, the rotor current vector must rotate an angle corresponding to accumulated skew at the axial location, before the vector difference is taken.

A particular 1/2-hp single-phase motor was studied for the variation across the stack. The results at full load are shown in Fig. 2. The figure shows there is a significant variation in the net fundamental mmf across the stack, and that the flux density is greatest on the end with the leading end of the rotor bars.

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Digest of paper 55-270, "Effect of Skew on Induction Motor Fields," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Middle Eastern District Meeting, Columbus, Ohio, May 4–6, 1955. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1955.

C. E. Linkous is with General Electric Company, Fort Wayne, Ind.

The author wishes to express his gratitude to M. L. Schmidt and F. W. Suhr of the General Electric Company for the many helpful ideas and suggestions contributed to this study.

INSTITUTE ACTIVITIES

The Kelley Mine of the Anaconda Company, Butte, Mont.

Pacific General Meeting Scheduled for August 15–17 in Butte, Montana

FINAL ARRANGEMENTS have been made for the Pacific General Meeting to be held this month, August 15–17, in Butte, Mont. Headquarters for this meeting is the Finlen Hotel.

Butte is often referred to as "the richest hill on earth" because of huge mineral deposits. Mining of these mineral ores is Butte's major industry. Copper is its chief mineral, although others are of importance—such as manganese which is mined three blocks from the business center. In fact, Butte was first activated as a placer gold mining area.

Technical Sessions, Inspection Trips

The technical program will have emphasis on the chief industries of the region. This includes mining and development of hydroelectric power. Also, the following inspection tours have been arranged.

Anaconda Company. Inspection trips are planned to surface and underground operations at the Kelley Mine of the Anaconda Company in Butte. At the Kelley Mine, visitors will be taken underground to see the inside workings of this huge operation which produces 12,000 to 15,000 tons of copper ore daily. This ore is hoisted to the surface through the world's largest mine shaft. Hoisting is accomplished with a 3,000-hp and a 2,500-hp d-c motor which will also be inspected. These trips will be arranged at no cost and transportation will be supplied. Trips will be arranged each day, Monday afternoon, August 13, to Wednesday morning, August 17, at 9:00 a.m. and 1:00 p.m., and will be limited to persons 18 years of age or over. Visitors will be furnished slickers, hard hats, and lights by the Anaconda Company.

At the Reduction Works at Anaconda, visitors will see equipment for unloading, crushing, and conveying not only the daily 15,000 tons from the Kelley Mine, but all of the rest of the ore produced on the Butte hill, plus ore produced by the Anaconda Company at Yearington, Nev. Besides the thousands of tons of copper and zinc reduced annually, 90 per cent of America's entire output of ferromanganese is produced here, and sulfuric acid, phosphate, and arsenic plants are found in the operations there. Also to be seen are rod mills, flotation plants, copper and zinc casting furnaces, electric ferromanganese furnaces, and all of the electric distribution and utilization equipment necessary for operations. This trip will be scheduled each day, Monday afternoon to Wednesday morning, at 8:45 a.m. and 1:15 p.m.

The Anaconda Company at Great Falls has regular plant tours each weekday at 10:00 a.m. and 2:00 p.m., and at 10:00 a.m. on Saturday. There are no regular Sunday tours for visitors. If members are desirous of seeing only electrical installations, they can contact F. S. Weimer, manager. The new Aluminum Rod Mill should be in operation by August 15. Equipment for this mill was manufactured in Sweden—both mechanical and electric. The Great Falls Wire and Cable Mill will probably prove interesting to delegates, too. And there are large electrolytic zinc and copper sections in this plant.

The Anaconda Company also invites delegates to visit the new aluminum plant at Columbia Falls, Mont. Members who want to visit this plant should contact Carl J. Lundborg, at 9:00 a.m., August 13, or 9:00 a.m., August 20.

The Montana Power Company. The Montana Power Company's Billings Steam Plant can be visited by members if they wish. They should contact George Scotten, Montana Power Office, Billings, Mont.

Tours of the Montana Power Company's Great Falls generating plants can be arranged by contacting Dix Shevalier, Montana Power Office, Great Falls, Mont. The Montana Power Company's Kerr Hydro Plant may also be visited.

U.S. Bureau of Reclamation. The U. S. Bureau of Reclamation invites delegates to visit either the Canyon Ferry project, near Helena, or the Hungry Horse project at Hungry Horse, Mont. The Canyon Ferry project does not have regularly conducted tours, but every effort will be made to conduct tours of the plant during the 3-week period starting August 7. Visitors are to contact the project superintendent, R. L. Ashenbrenner.

At the Hungry Horse project there are regular trips from 9:30 a.m. to 4:00 p.m. every day during the summer. These trips start from the top of the dam, and if delegates tell the attendant they are attending the convention, every effort will be made to give them the "de luxe tour." If any visitor desires more information, he should contact

E. L. Gochnauer, the project superintendent.

U. S. Army Engineers Installation. The U. S. Army Engineers installation at Fort Peck, Mont., is open to the general public from 9:30 a.m. to 5:30 p.m. Information stations are located at Fort Peck Glasgow and Fort Peck Nashua. Highway entrances to the Fort Peck project are open daily from 9:30 a.m. to 5:30 p.m. General information on the Fort Peck Dam and Fort Peck Recreational Area may be obtained at these stations.

Entertainment

On Monday evening, August 15, an informal western outing will be staged at the Columbia Gardens. After the hospitality hour, an outdoor dinner will be held featuring Butte pasty. Later in the evening there will be a western mixer dance with square dance exhibitions and other entertainment. Tickets will be $4.00 per person.

Tuesday evening is held open for informal visiting of Butte's famous steak houses or for visiting historical Virginia City and the Lewis and Clark Caverns. Wednesday's activity will center around the Butte Country Club for golf.

A dinner-dance will be held Wednesday night at the Butte Country Club and will feature a prime rib dinner. Formal dress is optional and tickets will be $4.00 per person.

The Virginia City trip takes several hours for the 178-mile round-trip jaunt. Virginia City was an early center of gold mining. In the evening, old time entertainment can be enjoyed at the Virginia City Playhouse.

Ladies Events

Registration for the ladies will be in the Finlen Hotel Lobby daily at 9:00 a.m. beginning August 15. Early arrivals may register August 14 at 3:00 p.m.

There will be a daily coffee hour, August 15–17, from 9:30 to 11:00 a.m., in the Finlen Hotel's Roundup Room. A tea will be held on Monday in the Fez Club from 2:30 to 4:30 p.m. Organ music is on the program and tickets will be $1.50.

A luncheon will take place in the Copper Bowl of the Finlen Hotel on Wednesday at 1:00 p.m. Elizabeth Lochrie and her Indian paintings will be featured. The luncheon is limited to 200 persons. Tickets will be $2.50.

Evaline Ball and Marjorie German are in charge of ladies registration. Dorothy Blankmeyer and Betty Kampschror will be hostesses at the coffee hour each morning, and the tea is being arranged by Dagmar Anderson and Priscilla Nealey. Flo Lorimer and Myrtle Hofacker are in charge of the luncheon.

Hotel Reservations

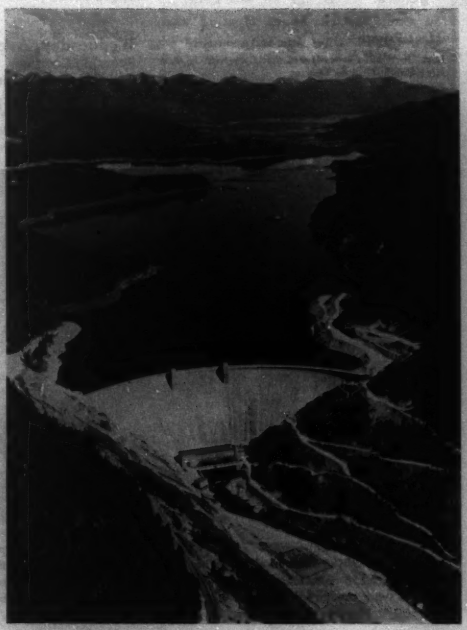
All hotel reservations should be sent directly to R. J. Labrie, Hotel Committee Chairman. Please make reservations early as accommodations are limited.

Finlen Hotel rates start at $4.75 for a single room and $6.50 for a double room with bath. Motel units can be obtained from $3.00 to $7.00, and rooms in other hotels in Butte may be obtained for $3.50 and $4.00.

Committee

The members of the Pacific General Meeting Committee are: W. H. Mott, chairman;

OLD FAITHFUL GEYSER in Yellowstone National Park is about 5 hours driving time from Butte, Mont., Pacific Meeting headquarters. Delegates on their way to or from the meeting may be able to fit a Yellowstone visit into their schedule.



HUNGRY HORSE PROJECT was built by the Bureau of Reclamation across the south fork of the Flathead River in northwestern Montana near Kalispell. It is located not far from the western edge of Glacier National Park.

R. C. Setterstrom, vice-chairman; D. E. Kampschror, secretary; R. J. Carlson, entertainment; R. C. Nealey, finance; R. J. Labrie, hotels and registration; W. H. Blankmeyer, publicity; Dale Scheckles, students; E. W. Schilling, technical program; N. V. Anderson, transportation and inspection trips; Mrs. C. A. Champ, ladies.

Tentative Technical Program
AIEE Pacific General Meeting

Monday, August 15

10:00 a.m. General Session

2:00 p.m. Transformers and Relays

*Minimum Cost Loading of Transformers. *Arthur Kloppenstein*, Southern California Edison Company

55-27 III. Impulse Tests on the Low-Voltage Windings of Distribution Transformers. *J. E. Holcomb*, General Electric Company. Re-presented for discussion

Automatic Reclosure—Operating Experience on the Pacific Coast. Report of the Pacific Coast Subcommittee, of the Committee on Relays

55-615 III. Automatic Load Shedding. Report of the Project Committee on Devices for Control of Load Shedding and System Separation

CP55-621. The Design Testing and Application of High-Voltage Condenser Bushings. *E. J. Grimmer*, Westinghouse Electric Corporation

2:00 p.m. Instruments and Measurements

CP55-616. A New Temperature Relay for Use With Resistance Temperature Detectors. *M. E. Hodges*, General Electric Company

CP55-617. Explosion-Proofing Instrumentation Equipment for Flight Test Use. *B. F. Hager*, Boeing Airplane Company

CP55-628. A CRT Spot Size Measuring Instrument. *R. B. Kuha, D. Levine*, Goodyear Aircraft Corporation

Tuesday, August 16

9:30 a.m. Electric Space Heating and Heat Pumps

Where Do We Go From Here? *L. M. Peoples*, Cowlitz County Public Utilities District

What Will We Use for Heat Tomorrow? *L. N. Roberson*, L. N. Roberson Company

9:30 a.m. Magnetic Amplifiers

CP55-619. Magamp Regulating Systems for Synchronous Machines. *J. V. Krasser*, Westinghouse Electric Corporation

55-620 I. Magnetic Amplifier Sequential Circuits of the Assymetrical Type. *A. S. Fitzgerald*, A. S. Fitzgerald Electrical Research Laboratories

Application of New Static Control Elements to the Control of an Automatic Welding Machine. *J. P. Connor, W. G. Evans, W. G. Hall, R. I. VanNice*, Westinghouse Electric Corporation

Transistorized Time Delays. *R. L. Bright, A. P. Kruper*, Westinghouse Electric Corporation.

An Excited Voltage Regulator for Environmental-Free Aircraft Alternators. *R. V. Evans*, North American Aviation

2:00 p.m. Land Transportation

2:00 p.m. Transmission and Distribution

55-622 III. Bureau of Reclamation 230-Kv Transmission Lines in North Dakota. *T. M. Austin*, Bureau of Reclamation

55-623 III. Power Autotransformer Current Interruption With an Air-Break Disconnect Switch. *M. W. Anderson*, Lighting Department, City of Seattle (Wash.)

Microwave, a New and Powerful Tool for Electrical Utility Operation. *T. A. Combellick*, Westinghouse Electric Corporation

CP55-624. Limitations in the Regulation of Non-infinite Bus Synchronous Systems. *B. J. Wilson, W. K. Gardner*, Naval Research Laboratory

Wednesday, August 17

9:30 a.m. Cathodic Protection

The Galvanic Corrosion Characteristics of Aluminum. *M. J. Pryor, D. S. Keir*, Kaiser Aluminum and Chemical Corporation

Panel Discussion on Cathodic Protection Practices:

Cathodic Protection in Electric Distribution Systems *O. W. Zastrow*, Rural Electrification Administration

Cathodic Protection in Telephone Underground Systems. *G. G. Thomas*, Mountain States Telephone and Telegraph Company

Cathodic Protection in Gas Distribution Systems (non-stray current areas). *D. P. Price*, Montana-Dakota Utilities Company

Cathodic Protection in Gas Distribution Systems (stray current areas). *C. R. Davis*, Montana Power Company

Cathodic Protection of Buildings, Refineries, and Industrial Plants. *H. J. Keeling*, consulting engineer

Instruments for Cathodic Protection. *R. M. Wainwright*, University of Illinois

55-625 II. Cathodic Protection Circuits. *E. W. Schwarz, R. M. Wainwright*, University of Illinois. Re-presented for discussion

9:30 a.m. Television, Measurements and Interference

A New Recording Method for Color Television Using Black and White Film. *W. L. Hughes*, Iowa State College

CP55-618. Pacific Northwest Television. *Dave Green*, Station *KXLY-TV*

Harmonic Measurements on Television Transmitters. *W. S. Byers*, General Electric Company

Design of Electronic Equipment for Radio Interference Reduction. *H. M. Sachs, A. L. Albin*, Armour Research Foundation of Illinois Institute of Technology

2:00 p.m. Safety

Electrical Installations and Safety Precautions Used in Underground Mining Operations. *W. R. Duffy*, Anaconda Copper Mining Company

Safety Problems on Diesel-Electric Locomotives. *R. A. Haeft*, Chicago, Milwaukee, St. Paul and Pacific Railroad

Milliamperes Can Kill You! (A demonstration of low-voltage electric shock hazards) *M. L. Bassett, B. A. Gurney, T. M. C. Martin*, Bonneville Power Administration

2:00 p.m. Community Antennas, Propagation and Satellites

Vhf-Uhf Tropospheric Research at the National

*Unnumbered papers may be available at and after the meeting if supplied by the authors. Publication by the Institute is not presently contemplated.

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TWO DOUBLE-DRUM HOISTS used at the Kelley Mine, Anaconda Company, Butte, Mont., are shown. The unit at the right is equipped with a 3,000-hp motor, the one on the left with a 2,250-hp motor. Each motor is supplied with 650-volt direct current from a 2,400-volt synchronous motor-generator set. The large hoist which at present brings ore from the 600-foot level to the surface can average one 15-ton "skip" per minute.

Bureau of Standards. *J. W. Hirshtrei*, National Bureau of Standards

Satellite and Booster Station Allocation Developments. *O. W. B. Reed, Jr.*, Jansky and Bailey

Experience in Receiving and Rebroadcasting Uhf-Television Signals. *J. B. Watkinson, KIMA* (presented by *Verne Russell*)

Community Television Antenna Systems. *A. S. Taylor*, consulting radio engineer

Petroleum Industry Conference to Be Held September 12–14, 1955

THE AIEE Second Electrical Conference of the Petroleum Industry will be held in Houston, Tex., September 12–14, 1955, at the Shamrock Hotel. The conference is sponsored jointly by the Institute's Petroleum Industry Committee and the Houston Section.

Houston, Tex., has a metropolitan population of over 1,000,000 and offers many recreational and historical facilities. Among them are the San Jacinto Monument and Museum which mark the site of the battle of April 21, 1836, where Texas won her independence from Mexico; the Museum of Fine Arts; and the Museum of Natural History.

Technical Sessions

The tentative technical program offers 23 papers covering a broad variety of electrical subjects in the refining, production, and transportation fields of the industry. The sessions will be open to all interested persons whether they be communication, petroleum, mechanical, chemical, or electrical engineers, or personnel interested in maintenance or operation. All the sessions will be held in the completely air-conditioned Shamrock Hotel.

Inspection Trips

Inspection trips will be offered to installations which will be of interest to the refinery, production, and transportation people, and have been arranged not to conflict with the technical sessions devoted to each of these three sections.

Production field trips include Schlumberger's multimillion dollar, modern well-surveying equipment manufacturing plant. All equipment used by Schlumberger is assembled there. Hughes Tool Company's bit and oil tool manufacturing plant (where drilling demonstrations in various formations will be shown with the aid of the world's only air-conditioned drilling rig) is also scheduled for inspection.

Transportation inspections will be offered at The Texas Pipe Line Company's East Houston station which is equipped with electric flow charts, motor-operated valves, and electric tank gauges, and at the Transcontinental Gas Pipe Line Corporation's microwave communication and control headquarters.

Refining field trips are to include the Sinclair Refinery and Humble Oil and Refining Company's Baytown Refinery. The Baytown Refinery is the world's largest high-octane gasoline refinery, where complete electrical distribution systems, instrumentation, and process controls will be demonstrated.

Social Activities

A stag luncheon is planned for noon Monday, September 12. Tuesday evening will be devoted to a fellowship and social hour and an informal banquet for the registrants and ladies. Many interesting activities are scheduled also for the ladies in attendance at the conference.

Hotel Reservations

For hotel reservations, preregistration forms, and programs write to J. C. Gardner, Westinghouse Electric Corporation, 507 Dallas Avenue, Houston 2, Tex. The advance registration fee is $3.50 and $4.00 for registration at the door at the time of the conference. Checks should be made payable to Clifton D. Campbell, Treasurer, Electrical Conference of the Petroleum Industry.

Advance Conference Papers

Advance copies of conference papers may be obtained by writing R. S. Gardner, Assistant Secretary, Technical Activities, Committee on Technical Operations, AIEE Headquarters, 33 West 39th Street, N. Y. C.

Tentative Technical Program Conference of the Petroleum Industry

Monday, September 12

8:00 a.m. Registration

10:00 a.m. General Session

10:30 a.m. Refining

Presiding: W. H. Dickinson, Esso Research and Engineering Company

Current Practices in Classifying Areas for Electrical Installations. *Dr. L. M. Goldsmith*, Atlantic Refining Company

Power Systems for New Refinery With Major Electric Drives. *N. A. Austin*, Standard Oil Company of California

2:00 p.m. Refining

Presiding: W. H. Dickinson

CP55-638 Modern Protective Relaying for Refinery

Future AIEE Meetings

Pacific General Meeting
Butte, Mont.
August 15–17, 1955
(*Final dates for TP*—closed, CP†—closed*)

Petroleum Technical Conference
Shamrock Hotel, Houston, Tex.
September 12–14, 1955
(*Final date for submitting papers—closed*)

AIEE-ISA Instrument Conference
Shrine Auditorium, Los Angeles, Calif.
September 12–16, 1955
(*Final date for submitting papers—closed*)

AIEE-IRE Industrial Electronics Conference
Rackham Memorial Auditorium, Detroit, Mich.
September 28–29, 1955
(*Final date for submitting papers—closed*)

1955 Fall General Meeting
Morrison Hotel, Chicago, Ill.
October 3–7, 1955
(*Final dates for TP—closed, CP—August 3*)

Motor Application and Problems in Heating and Cooling Conference
St. Louis, Mo.
October 19–20, 1955
(*Final date for submitting papers—closed*)

Aircraft Electrical Equipment Conference
Hollywood Roosevelt Hotel
Los Angeles, Calif.
October 25–27, 1955
(*Final date for TP—closed, CP—Aug. 25*)

Middle Atlantic Textile Conference
North Carolina State College, Raleigh, N. C.
November 3–4, 1955
(*Final date for submitting papers—August 3*)

AIEE-IRE-ACM Eastern Computer Conference
Hotel Statler, Boston, Mass.
November 7–9, 1955
(*Final date for submitting papers—August 8*)

Electrical Techniques in Medicine and Biology Conference
Shoreham Hotel, Washington, D. C.
November 14–16, 1955
(*Final date for submitting papers—August 15*)

EJC-AIEE Nuclear Energy Conference
Cleveland, Ohio
December 12–16, 1955
(*Final date for submitting papers—September 12*)

Winter General Meeting
Hotel Statler, New York, N. Y.
January 30–February 3, 1956
(*Final date for TP—Oct. 20, CP—Nov. 30*)

*TP—Transactions papers
†CP—Conference papers

HOUSTON, TEX., will be the scene of the second Electrical Conference of the Petroleum Industry. Above is the San Jacinto Battleground, 18 miles southeast of Houston where the U.S.S. Texas (center of picture) is permanently moored as a Texas shrine.

CP55-631 Lighting in a Petroleum Refinery. *B. E. Gilman*, Standard Oil Company of Indiana

Insulated Cables and the Petroleum Industry. *E. E. McElheme*, Okonite Company

Installation and Maintenance of 15.8-Kv Gas-Filled Cable Installation. *B. E. Crawford, J. A. Darden*, Esso Standard Oil Company

9:30 a.m. Production

Presiding: J. R. Ashley, Magnolia Pipe Line Company

Electric Power in Modern Gasoline Plant Construction. *E. A. Noser*, Hudson Engineering Company

CP55-635 An Attempt to Reduce Glare During Night Operations on a Drilling Rig. *J. R. Street*, Texas Employer's Insurance Association

CP55-634 Motor-Switched Capacitors for Beam Pumping. *R. K. Owen*, Southwestern Public Service Company

2:00 p.m. Production

Presiding: M. H. Halderson, Phillips Petroleum Company

A Solution to the Problems of Oil-Well Drilling in Urban Areas. *Earl Knox*, Packo Consulting Engineers; *E. E. Hogwood, Jr.*, Westinghouse Electric Corporation

New Applications of Electric Drives to Drilling Rigs. *G. W. Webb*, General Electric Company

Electric Wiring of Drilling Barges and Off-Shore Structures. *H. S. McIntosh*, McIntosh Electric Supply Company, Inc.

2:00 p.m. Transportation

Presiding: R. S. Cannon, Plantation Pipe Line Company

CP55-629 Maintenance of Gas Turbine Equipment in Natural Gas Pumping Stations. *J. C. Arnold*, El Paso Natural Gas Company

CP55-632 Special Applications of Standard Switchgear for Pipe-Line Substations. *V. G. Murdock*, Allis-Chalmers Manufacturing Company

CP55-633 New Horizons in Gauging and Sampling. *F. E. Neaf, Jr.*, Gilbert and Barker Manufacturing Company

CP55-637 Automatic Operation of Pipe-Line Pump Stations. *C. S. Williams*, Texas Pipe Line Company

Wednesday, September 14

9:30 a.m. Transportation

Presiding: A. R. Heidedrecht, Platte Pipe Line Company

Present Status of Remotely Operated Pumping Stations. *E. B. Turner*, General Electric Company

CP55-636 Modernized and Simplified Methods for Controlling Pumping Stations Automatically. *R. J. Thompson, T. H. Puckett*, Carnahan and Thompson Engineers

CP55-630 Time Code Control and Data Handling Systems. *P. K. Eckhardt*, Union Switch and Signal Company

CP55-639 Protective Instruments and Their Safety Functions for Today's Pipe Lines. *P. J. Provost*, Mercoid Corporation

Electric Systems. *W. C. Woods*, Westinghouse Electric Corporation

System Neutral Grounding for the Petroleum Industry. *D. S. Brereton, H. N. Hickok*, General Electric Company

34.5-Kv Station-Type Cubicle Switchgear in a Petroleum Refinery. *W. E. Highfill*, Esso Research and Engineering Company

Motor Starting Problems in a Petroleum Refinery. *L. B. Eddy*, Universal Oil Products Company

Tuesday, September 13

9:30 a.m. Refining

Presiding: W. H. Dickinson

High-Voltage Motor Controllers for the Petroleum Industry. *T. J. Render*, General Electric Company

HEADQUARTERS for this year's Petroleum Conference is the air-conditioned Shamrock Hotel.

A Successful AIEE Summer Meeting Is Indicated at Opening of General Session

THE 1955 AIEE SUMMER GENERAL MEETING is being held at Swampscott, Mass., at the time of this writing (June 27–July 1). The Boston and Lynn Sections are acting as hosts. Although at this time, after the General Session, the meeting is just getting under way, the enthusiasm of those attending indicates a successful meeting, both socially and technically. There are 47 technical sessions and conferences scheduled for the meeting.

At the General Session, AIEE President A. C. Monteith presented his report of the past year to the members. (For the full report, see pages 639–41 in this issue.) AIEE Secretary N. S. Hibshman explained some of the highlights of the report of the Board of Directors and told how the maps on the report's cover symbolize the progress the Institute has made in the past year from a geographic standpoint.

Walter Barrett, as Institute Treasurer, explained that although some of the reserve capital fund had to be disposed of, the fund shows a healthier condition than it did at this time last year because of the general increase of stock-market prices.

Secretary Hibshman read the tellers' report on the voting for the four proposed amendments of the Constitution. Results were:

Amendment 1—For 17,886; Against 782
Amendment 2—For 18,193; Against 474
Amendment 3—For 16,785; Against 1,774
Amendment 4—For 18,283; Against 270

Mr. Hibshman then presented the report of the tellers for the election of new officers for 1955–56. For president, Morris Hooven received more than 15,000 ballots and the following Vice-Presidents from the even-numbered districts were elected by approximately the same number of votes: District 2, C. T. Pearce; District 4, W. J. Miller; District 6, E. R. Jones; District 8, Bradley Cozzens; and District 10, B. G. Ballard. New directors are J. D. Tebo, P. G. Wallace, and J. C. Woods.

President Monteith then gave some of the highlights of Morris Hooven's Institute work and presented him with the AIEE President's badge. In replying, Mr. Hooven thanked members for the honor and pledged he would endeavor to guide the Institute along the same channels which Mr. Monteith had opened.

Next A. M. deBellis was presented with the Lamme Medal. (A complete report of the history of the medal, the medalist's career, and his response are on pages 662–65.)

G. J. Crowdes, Vice-President of District 1, announced the winners of the District's prize paper competition. They were: R. H. Klein and C. Mannal, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y., first prize of $75 for "The Effects of High-Energy Gamma Radiation"; and P. A. Abetti and H. F. Davis, General Electric Company, Pittsfield, Mass., second prize of $50, for "Surge Transfer in 3-Winding Transformers."

The District Student Paper Prize Winners were then introduced. These students were brought to the meeting through the Members-for-Life Fund. They were: North Eastern (1), L. A. Mende, Cornell University; Middle Eastern (2), A. W. Ladd and J. D. Lam-

MEETING HIGHLIGHTS

June 27–July 1, 1955
Summer General Meeting

CONGRATULATIONS (center picture) were given to Morris Hooven, 1955–56 AIEE President, by Secretary of the Institute N. S. Hibshman (right) and A. C. Monteith, 1954–55 AIEE President (left). Lamme Medalist (left picture) A. M. deBellis (second from right) was presented with the medal and a certificate during the General Session. To his left are J. F. Fairman, who described the medalist's career and immediate Past President Monteith. To his right is S. B. Crary, chairman of the AIEE Lamme Medal Committee. Some of the student winners (right picture) of District paper competitions were at the meeting through the Members-for-Life Fund. At far left is outgoing president Monteith and at far right is incoming president Morris Hooven. Students are (left to right): J. D. Lambert, University of Cincinnati; Charles Hartley, State College of Washington; James Treible, Marquette University; Robert Bergman, J. E. Sparks, University of Wyoming; Arvin Grabel, New York University; Mark Biedebach, University of Southern California; and Morton Mullins, Missouri School of Mines and Metallurgy. Registration as of noon, June 28, the second day of the meeting, was 1,500.

bert, University of Cincinnati; New York City (3), Arvin Grabel, New York University; Southern (4), R. H. Dietz, Jr., University of Alabama; Great Lakes (5), J. C. Treible, Marquette University; North Central (6), John Sparks and Robert Bergman, University of Wyoming; South West (7), M. L. Mullins, Missouri School of Mines and Metallurgy; Pacific (8), M. C. Biedebach, University of Southern California; North West (9), C. R. Hartley, State College of Washington.

1955 AIEE Fall General Meeting Will Be Held in Chicago, Ill., Oct. 3–7

THE 1955 FALL GENERAL MEETING of AIEE will be held in Chicago, Ill., October 3–7. Headquarters for the meeting will be at the Morrison Hotel.

Technical Sessions

The technical program, comprising about 50 sessions, will cover a wide range of electrical interests. In the Power Division, committees are planning sessions on power generation, rotating machinery, transformers, transmission and distribution, switchgear, system engineering, insulated conductors, etc.

In the field of science and electronics, the following sessions are being planned: basic science, computing devices, electronics, and nucleonics. Other sessions will cover television and aural broadcast, telegraph systems, wire communications, communication switching, carrier current, feedback control systems, education, safety, and management.

The committees concerned with the Industry and General Applications Division are developing sessions on land transportation, mining and metals, industrial power systems, chemical industrial applications, etc.

Kaufman and Fabry

A SKYLINE VIEW is shown of Chicago, Ill., where AIEE's Fall General Meeting will be held October 3–7, 1955, at the Morrison Hotel.

Inspection Trips

Among the inspection visits planned, are trips to the Ford aircraft plant; The Standard Oil refinery at Whiting, Ind.; the electromotive plant of General Motors Corporation at LaGrange, Ill.; The Rauland Corporation; and the New Will County Station of the Commonwealth Edison System. This station, which has been under construction for 3 years, went into service with the first 160,000-kw generating unit in March. A second unit will be completed this summer, in time for the meeting.

Smoker

Social events will include a reception and a smoker. The latter will be on Monday evening, October 3. Tickets will be $10.00 each. Available seating arrangements permit tables for six, eight, or ten. The Terrace Casino in which the smoker will be held is limited to about 1,100 persons. Since the National Electronics Conference, being held in Chicago the same week, has been invited to participate in the smoker, members are urged to send reservations early. All requests for reservations must be accompanied by a check in order to be validated. Checks should be made out to: E. H. Finch, Chairman,

Smoker Committee, Sargent and Lundy, 140 South Dearborn Street, Chicago 3, Ill.

Committee

Members of the 1955 Fall General Meeting Committee are: F. A. Cox, chairman; W. M. Ballenger, vice-chairman; H. R. Stevens, secretary; R. W. Jones, treasurer; Merlin J. Adams, dinner-dance; G. E. Buchanan, registration; E. H. Finch, smoker; Mrs. R. B. Gear, ladies activities; A. W. Kramer, publicity; R. M. Bergalien, technical program; F. A. Larson, entertainment; E. H. McNeill, hospitality; M. J. O'Laughlin, sale of papers; D. C. Pearcy, trips and transportation; F. M. Scott, finance and budget; G. L. Welch, hotel arrangements, and E. R. Whitehead, general session.

August 11 Is Deadline for Papers on Aircraft Electrical Applications

The Institute's annual fall Technical Conference on Aircraft Electrical Applications will be held in Los Angeles, Calif., October 25–27, at the Hollywood Roosevelt Hotel. The conference, sponsored by the Committee on Air Transportation, has been scheduled to coincide with the annual Aircraft Electrical Society display meeting and the Society of Automotive Engineers' *A-2* Committee Meeting. This will allow visiting delegates to combine three conferences to make the most profitable use of their time.

A program of technical progress is being planned. This program will cover various phases of aircraft electric power generation and control, component design, engineering department management, and personnel training. Those attending the conference will have an opportunity to participate in field trips featuring a 1-day cruise on an aircraft carrier. The Ladies Committee is arranging an interesting program, a highlight of which will be a trip through Disneyland.

All papers presented that are received in reproducible form at AIEE Headquarters by August 11 will be preprinted and made available at the conference.

Heating and Cooling Space Equipment Conference Is Set

A Conference on Application of Motors to Space Heating and Cooling Equipment will be held in St. Louis, Mo., at the Chase Hotel, October 19–20. Registration will be from 9:00 to 9:30 a.m. on Wednesday followed by a general session and a short technical session.

There will be technical sessions Wednesday afternoon and Thursday morning and afternoon. Luncheons will be held Wednesday and Thursday and also on Wednesday there will be a dinner with a well-known speaker. This part of the activity will be in connection with the October meeting of the St. Louis Section of AIEE.

Telemetering Conference Record Available in Limited Quantities

At the 1955 National Telemetering Conference held at the Morrison Hotel, in Chicago, Ill., May 18–20, 1955, those attending could purchase (for $3.50), a complete bound copy of the "1955 National Telemetering Conference Record." This record contains papers on 212 pages, size 8½ by 11 inches. The timely availability of the record received favorable comment. Limited quantities of this record are now available through the four sponsoring societies: AIEE, Institute of Radio Engineers, Instrument Society of America, and the Institute of the Aeronautical Sciences.

Industrial Electronics Conference to Be Held September 28–29, 1955

A conference on industrial electronics will be held in Detroit, Mich., September 28–29. This symposium, the 1955 Industrial Electronics Conference will be cosponsored by AIEE and the Professional Group on Industrial Electronics (PGIE) of the Institute of Radio Engineers. It is expected that about 300 engineers will gather in Detroit during the 2-day session to discuss automation, industrial measurement problems, and new control system applications. A total of 16 papers have been tentatively scheduled for the four technical sessions to be held in the Engineering Society of Detroit Auditorium.

Co-chairmen of the affair are S. Sterling of S. Sterling Company and H. S. Mika of Ford Motor Company. Official convention headquarters will be the Park Sheraton Hotel and Guido N. Ferrara has been named chairman of the hotel and registration committee. He can be contacted at 8106 West Nine Mile Road, Oak Park 37, Mich. The registration fee will be $3.00 and all registrants at the conference will receive copies of the PGIE *Transactions* which contain the papers delivered at the meeting.

Lehigh Valley Section Honors Its Past Chairmen

The Lehigh Valley Section met to honor past chairmen who were special guests at the May 13 meeting. W. B. Morton, Vice-President of District 2, presented these past chairmen with certificates and pins: D. M. Petty, J. L. Beaver, W. H. Lesser, H. D. Baldwin, A. J. Althouse, W. M. Harbaugh, Morland King, J. G. Charest, N. S. Hibshman, C. J. MacDonald, O. A. Gricsemer, E. F. Weaver, J. W. Mills, E. R. Beers, R. M. Wyatt, H. E. Pearson, L. Z. Ludorf, R. E. Neidig, F. W. Smith, J. E. Treweek, C. H. Sprague, J. O. Leslie, D. A. Campbell, Jr., and J. H. Black.

N. S. Hibshman, AIEE Secretary, gave a brief speech of acceptance on behalf of the former chairmen. C. J. MacDonald, formerly of Forty Fort, Pa., traveled from San Francisco, Calif., to receive his certificate. Mr. MacDonald is employed by the Bechtel Corporation in San Francisco.

R. E. Fuhrman of the Reading Division was awarded a prize as the member most successful in furthering the work of the membership committee and F. M. Fuller, historical committee chairman, presented a recently completed history of the Section.

D. L. Greene, present chairman, announced the officers that have been elected for 1955–56. They are: Chairman S. C. Townsend; Vice-Chairmen L. V. Bewely, W. F. Dunkle, and L. F. Anderson; Secretary-Treasurer F. S. Fehr. Managers are: J. C. Gray, Allentown Division; C. L. Eichenberg, Bethlehem Division; D. D. Smith, Wilkes-Barre Division; D. H. Jackson, Scranton Division; C. J. Mayer, Williamsport Division; R. E. Peterson, Easton Division;

Hollywood Roosevelt Hotel, Los Angeles, Calif.

CERTIFICATES WERE GIVEN to former chairmen at Lehigh Valley Section's May 13 meeting. Above are: (back row, left to right) D. A. Campbell, Jr., C. H. Sprague, J. L. Beaver, E. R. Beers, J. G. Charest, N. S. Hibshman, J. W. Mills, J. H. Black, J. E. Treweek, H. D. Baldwin, and (front row, left to right) O. A. Griesemer, W. H. Lesser, D. M. Petty, E. F. Weaver, J. O. Leslie, H. E. Pearson, L. Z. Ludorf, C. J. MacDonald, W. M. Harbaugh. Others who received certificates but were not present when the picture was taken: A. J. Althouse, Morland King, R. M. Wyatt, R. E. Neidig, and F. W. Smith.

P. H. Robbins, Reading Division; G. A. Irland, Sunbury Division; and H. R. Steward, Hazleton Division.

Guest speaker Byron O. McCoy, hydraulic engineer with Charles T. Main, Inc., Boston, Mass., explained the engineering features of the St. Lawrence hydroelectric development. He is currently engaged in the design of the proposed control and power dams on the St. Lawrence River.

He said that the St. Lawrence development is being constructed jointly by the New York State Power Authority (NYSPA) and the Hydro-Electric Power Commission of Ontario (HEPCO) in the International Rapids section of the river 75 miles from Montreal.

It is estimated that the project will cost $561,000,000, which is being shared jointly by the NYSPA and the HEPCO.

Mr. McCoy added that three dams are tentatively proposed—one at Barnhart Island, the Long Sault Dam, also in the vicinity of Barnhart Island; and the Iroquois Dam, to be located 30 miles upstream where its function will be to control the level of Lake Ontario.

Mexico Section of AIEE Has Three Guest Speakers

The Mexico Section of AIEE had three distinguished guest speakers at the June 2 meeting. They were: Harry Gobberg, co-ordinator of the Phoenix Project of the Fund for Peaceful Development of Atomic Energy; Melburn Spector, deputy director, Point Four Program, American Embassy; and E. Blyth Stason, dean of the College of Laws, University of Michigan. The theme of their talks was "Peaceful Development of Atomic Energy."

Other honored guests were: Gustavo Maryssael, director general of the Mexican Light and Power Company; Basil Nikiforoff, technical director of the Mexican Light and Power Company; and Carlos Ramirez Ulloa, head of the Comision Federal de Electricidad.

New officers who were installed at the meeting were: Hector Martinez D'Meza, chairman; Francisco Aubert, vice-chairman; Eduardo Nieto Palacios, secretary; and Jorge Lozano Vez, treasurer.

Some AIEE Student members from the National School of Engineering were also present.

First Woman Qualifies for Ridgway Section Scholarship

As part of Ridgway Section's vocational guidance program the Section sponsors an annual scholarship in the amount of $1,200 for 4 years to any qualifying student who will attend an accredited engineering school. This year's scholarship winner is Miss Rita Mary Clopp of Wilcox Jones Township High School. Miss Clopp is the first woman

AIEE Committee on Switchgear

THE AIEE COMMITTEE ON SWITCHGEAR held a well-attended meeting on May 20 at the Hotel Hershey, Hershey, Pa. Among the items of standardization work on the agenda were capacitor switching and a new basis for rating power circuit breakers and its effect on other switchgear devices. Seated in the first row are: Committee Secretary K. J. Falck (fourth from left); Chairman J. D. Wood (to the right of Mr. Falck); and Vice-chairman J. C. Woods (fourth from right). (No items appear in the "Committee Activities" column this month because of change in committee personnel.)

Rita Clopp

to qualify for the scholarship which is based on a personality and aptitude test conducted by the Section's scholarship committee. The scholarship for the past 2 years has consisted of contributions from local industries.

The Section began this project in 1950 when it was the Ridgway Subsection. (See *Electrical Engineering*, April 1953, page 364.)

Spokane Section Holds Final Meeting of the Year

The Spokane Section recently held its final meeting of the year. Student members were invited from Branches at the State College of Washington (Pullman) and the University of Idaho (Moscow) as dinner guests. The evening's program consisted of the installation of officers for the coming year, a student paper competition, and a talk, "Management's Role in Engineering," by W. L. Thrailkill, assistant general manager of The Washington Water Power Company, Spokane.

New officers are: N. H. Meyers, General Electric Company, chairman; Jack Fox, Kaiser Aluminum and Chemical Corporation, vice-chairman; R. D. Brown, Allis-Chalmers Manufacturing Company, secretary-treasurer.

Winner of the student prize paper contest was George Kronmiller, University of Idaho, for "A Versatile Voltage Regulator for Laboratory Use." His award is a year's membership (Associate) in AIEE, presented by the Section.

Erie Section Holds Final Meeting of Season

"Light Begins at 80" was AIEE Vice-President W. B. Morton's topic at the June 2 Erie Section meeting. Mr. Morton addressed approximately 65 Erie Section members at the final meeting of the season.

He first talked about Thomas Edison's incandescent lamp invention in 1880 and then made a transition to the field of power generation. Slides were shown of Edison's second power station replica at the Sunbury Plant, Pennsylvania Power and Light Company, near Allentown, Pa. The original installation had a capacity of 51 hp and occupied an area about the same as that of a 2-car garage. Today the Sunbury Plant occupies approximately 250 acres and has a capacity of 300,000 kw.

Manpower in the Edison plant originally consisted of one man who acted as bill collector in the daylight hours. Now there are 300 employees, in a 24-hour operation, with distribution voltages of 66 and 220 kv.

To keep the members up-to-date, Vice-President Morton also gave a brief illustrated presentation on the over-all organization of the Institute. This included a breakdown from the Board of Directors to the various committees. A map giving the boundaries of the Districts throughout the United States, Canada, and Mexico, was shown.

Certificates and cash awards were presented to prize paper competition winners by Chairman Charles Moon. Winners were: first prize, Walter Gribble, Erie Resistor Corporation, "Voltage Divider Network for a Photomultiplier Tube"; second prize, Frank Davis, General Electric Company, "New NEMA (National Electrical Manufacturers Association) Standards for D-C Motors and Generators"; and third prize, Ralph Walter and Russ Skiff, General Electric Company, "Cast Resin Solenoid Coils."

Also at this meeting certificates were presented to the following past Section chairmen: C. P. Yoder (1918–19); M. C. Goodspeed (1920–21); M. W. Metzner (1923–24); G. R. McDonald (1930–31); W. D. Bearce (1933–34); J. W. Teker (1936–37); R. W. Barrell (1938–39); F. H. Craton (1939–40); J. D. Heibel (1940–41); H. G. Moore (1941–42); H. N. Shaw (1943–44); J. Hause (1944–45); H. S. Ogden (1945–46); L. Greer (1946–47); M. W. Kitzmiller (1947–48); C. L. Reed, Jr. (1948–49); M. J. Kolhoff (1949–50); K. H. Ishler (1950–51); C. B. Lewis (1951–52) and F. D. Reese (1952–53).

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until *August 31*. Duplicate double-spaced typewritten copies of each discussion should be sent to Edward C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y., on or before *August 31*.

55-92 **Transfer Tests on Station Auxiliary Busses.** *L. E. Backer, Paul Barth, R. A. Huse, and D. W. Taylor*

55-261 **Aluminum in Heavy-Current Conductors.** *William Deans.*

Preprints may be purchased at 30¢ each to members, 60¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

SPOKANE SECTION'S 1954–55 chairman, Harold C. Martindale (left), presents gavel to N. H. Meyers (right), chairman-elect for 1955–56, of the final meeting of the season, while W. L. Thrailkill (center) looks on. Mr. Thrailkill was speaker at the dinner-meeting.

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Note. Because of the changeover in committee personnel, no items appear in this column this month.

AIEE FELLOWS ELECTED..

Board of Directors Meeting, April 14, 1955

W. C. Johnson

R. D. Maxson

Walter Curtis Johnson (AM'35, M'42), chairman, department of electrical engineering, Princeton University, Princeton, N. J., has been transferred to the grade of Fellow in AIEE "for contributions as author, teacher, and research worker in the field of electrical engineering." Mr. Johnson was born in Weikert, Pa., January 6, 1913. He obtained his bachelor of science degree in electrical engineering from The Pennsylvania State University in 1934 and his electrical engineer degree in 1942. After graduation in 1934 he joined the General Electric Company in Schenectady, N. Y., as a student engineer. He took a 3-year advanced course in engineering and was on rotating assignment in various engineering departments of the company. In 1937 he became an instructor at Princeton. He became assistant professor in 1940, associate professor in 1943, professor in 1947, and chairman of the electrical engineering department in 1950. He originated a course in engineering analysis in 1937 and developed class notes for this subject into a textbook. He has had charge of undergraduate courses in electric circuit theory, electric machinery, and engineering analysis, and graduate courses in network theory and electromagnetic field theory. His principal recent research interest has been the development of the theory of magnetic amplifiers. At various times he has been consultant for RCA Laboratories, General Electric Company, Franklin Institute, Richardson-Allen Corporation, Research Corporation, and Applied Science Corporation of Princeton. He is the author of "Mathematical and Physical Principles of Engineering Analysis," McGraw-Hill Book Company, Inc., New York, N.Y., 1944, and "Transmission Lines and Networks," McGraw-Hill Book Company, Inc., 1950. His articles for AIEE publications have included: "Predetermination of Temperatures in Resistance Welds," AIEE *Transactions*, vol. 58, 1939, pp. 835–53; "A New Method for Introducing Relaxed Initial Conditions in Transient Problems," AIEE *Transactions*, vol. 60, 1941, pp. 178–81; "Universal Curves for D-C Controllable Reactors," AIEE *Transactions*, vol. 68, 1949, pp. 31–7; "An Analysis of Transients and Feedback in Magnetic Amplifiers," AIEE *Transactions*, vol. 69, 1950, pp. 604–11 (coauthor); "The Magnetic Amplifier," *Electrical Engineering*, July 1953, pp. 583–8. Articles taken from his 1949 and 1950 AIEE *Transactions* papers have also appeared in *Electrical Engineering*. He has had articles, technical papers, book reviews, etc., in the *Journal*, Engineers Council for Professional Development, as well as published work in the *Proceedings* of the Institute of Radio Engineers and in *Industrial and Engineering Chemistry*. He is a member of the American Physical Society, Sigma Xi, and a senior member of the Institute of Radio Engineers.

Raymond Dewey Maxson (M'44), senior vice-president, Commonwealth Edison Company, Chicago, Ill., has been transferred to the grade of Fellow in AIEE "for contributions to the integration of the engineering practices of several companies into a combined power system." Mr. Maxson was born March 12, 1898, at Rochelle, Ill. He attended Bradley University and the University of Illinois. He received his bachelor of science degree in electrical engineering from the University of Illinois in 1921. He then joined the Public Service Company of Northern Illinois (Chicago) as assistant inspector, inspection department, at Crystal Lake. He became assistant in the electric distribution department, Chicago, and then district inspector. From 1926–29 he was administrative assistant, office of the vice-president in charge of operations. From 1929–33 he was assistant electrical engineer working on application of metal-clad switchgear purchased from abroad in the United States and on new engineering practices such as cables in place of open wire for distribution systems in suburban and rural areas, including aerial cables. By 1943 he was vice-president after having progressed through the following positions: assistant division manager, Maywood, Ill.; division manager, Maywood, and manager of gas operations, Chicago. During the time he was manager of gas operations there was a change in the system from manufactured gas to natural gas. From 1943 to 1952 he was vice-president in charge of engineering, construction and maintenance, substations, testing, and research. As officer in charge of engineering, Mr. Maxson was responsible for major engineering improvements. This included the co-ordination of the engineering practices of the Public Service Company of Northern Illinois, Western United Gas and Electric Company, and Illinois Northern Utilities Company. The integration of the systems of these three companies was a necessary step for the consolidation of Western United Gas and Electric Company and Illinois Utilities Company into Public Service Company of Northern Illinois. Following this consolidation, Mr. Maxson was largely responsible for the co-ordination of practices and the further integration of the Public Service Company with the Commonwealth Edison Company. In 1952 he became vice-president in charge of engineering, construction and maintenance, substations, testing, and research for Commonwealth Edison Company. He completed the merging of engineering activities of the two companies (Commonwealth and Public Service), which activity culminated in the merger of Public Service Company of Northern Illinois and Commonwealth Edison Company in 1953. Throughout his carreer he has advocated and carried through experimentation in many new practices in electrical utility operations, such as pipe-type high-voltage cable, automatic substations, remote-controlled substations, bus regulation of voltage, and automatic load control of generators. Beginning in February of this year he has been assisting in the administration of the duties of the president of Commonwealth Edison. He is a member of the Western Society of Engineers, Tau Beta Pi Association, and Eta Kappa Nu Association. He also has served on the Institute's Committee on Code of Principles of Professional Conduct (1947–53).

AIEE PERSONALITIES.....

E. I. Green (AM'23, F'46), director of military communication systems at Bell Telephone Laboratories, Inc., New York, N. Y., has been elected vice-president in charge of systems engineering. Mr. Green has 34 years of service with the Bell System. He began his telephone career in 1921 with the American Telephone and Telegraph Company's development and research department, and with that department transferred to Bell Laboratories in 1934. For a considerable time he specialized in development work on toll transmission systems, with particular interest in multiplex telephone and telegraph systems. During World War II he was engaged in development work on radar-testing apparatus and other electronic equipment. He was appointed director of transmission apparatus development in 1948 and in 1953 was named director of military communication systems. He received a bachelor of arts degree from Westminster College in

Fabian Bachrach

E. I. Green

1915 and a bachelor of science degree in electrical engineering from Harvard University in 1921. He is a fellow of the Institute of Radio Engineers.

M. J. Kelly (M'26, F'31) president of Bell Telephone Laboratories, New York, N.Y., has been named to the Board of Trustees of Stevens Institute of Technology, Hoboken, N. J. (He also received an honorary doctor of engineering degree from New York University (NYU) this year at the final centennial convocation of NYU's engineering college.) Dr. Kelly has been a leading figure in electronic and acoustical research for many years. He has served as chairman of the U. S. Air Force's Scientific Advisory Board, and as advisor to the Secretary of the Air Force, the Atomic Energy Commission, and other defense agencies. An alumnus of the Missouri School of Mines, he received his master's degree from the University of Kentucky and his doctorate from the University of Chicago. He is a fellow of the American Physical Society, the Acoustical Society of America, and the Institute of Radio Engineers. He is also a member of the National Academy of Sciences, and the honorary scientific and engineering societies Tau Beta Pi, Eta Kappa Nu, and Sigma Xi. In April 1954, he was awarded the 1954 medal of the Industrial Research Institute for his "distinguished leadership in industrial research." He has served on the following AIEE committees: Communication (1934–37); Standards (1934–39, 1941–43); Basic Sciences (1937–46); Lamme Medal (1940–43); Research (1940–45, 1947–51, Chairman 1949–51); Award of Institute Prizes (1949–51); and Technical Program (1949–50).

D. A. Quarles (AM '23, F'41), Assistant Secretary of Defense for Research and Development, Washington, D.C., received an honorary doctor of engineering degree from New York University's College of Engineering at the final centennial convocation of the engineering college. Mr. Quarles, who was president of the Institute for 1952–53, was formerly a vice-president of the Bell Telephone Laboratories, Inc., New York, N.Y.; president of Sandia Corporation, Albuquerque, N. Mex.; and vice-president, Western Electric Company, Inc., New York, N.Y. He was born on July 30, 1894, in Van Buren, Ark., and was graduated from Yale University in 1916 with a bachelor of arts degree. During World War I he served with the United States Army for 2 years before he was discharged with the rank of captain. In 1919 he joined the Western Electric Company Engineering Department which, in 1925, became Bell Telephone Laboratories, Inc. From 1919 to 1924 he was in transmission engineering and research and then for 4 years he was a member of the inspection engineering department in charge of apparatus inspection engineering. He was made director of outside plant development in 1929 and was in charge of the study of telephone materials and designs used in the outside plant and the development of new and improved materials and designs. As director of transmission development from 1940 to 1944, he was in charge of the development of carrier telephone systems, broad-band telephone and television systems, and improved voice-frequency transmission systems. He was elected a vice-president of the Laboratories in 1947. Mr. Quarles was vice-chairman of the committee on electronics of the Government's Joint Research and Development Board. He is a member of the American Physical Society, the Institute of Radio Engineers, the Yale Engineering Association, the American Association for the Advancement of Science, and the Telephone Pioneers of America. He has served the AIEE as a director and on many committees including: Finance (1944–48, Chairman 1946–48); Edison Medal (1945–47, 1953–55); Electronics (1945–47); Instruments and Measurements (1945–46); Library Board, United Engineering Trustees, Inc. (1945–46); Board of Trustees, AIEE Retirement System (1945–48); Planning and Co-ordination (1946–48); Headquarters (1946–48); Lamme Medal (1947–50); Management (1948–52); Board of Directors (1944–48; 1952–55); Board of Trustees, United Engineering Trustees, Inc. (1948–54); Executive (1952–54, Chairman 1952–53); John Fritz Medal (1953–55).

S. W. Neidorf (AM '36), in charge of all engineering departments, Hermetic Seal Products Company, Newark, N. J., has been appointed vice-president and general manager in charge of operations, to supervise and take charge of the complete operation of Hermetic's three plants. Mr. Neidorf joined Hermetic in November 1948 as chief engineer and factory manager. He was formerly associated with International Telephone and Telegraph Company's General Manufacturing Division, for which he pioneered the cable manufacturing industry in Buenos Aires, Argentina. He was also formerly associated with Tung-Sol Electric Inc. and with the Federal Telephone and Radio Company. Mr. Neidorf graduated from Newark College of Engineering in 1935 where he received a bachelor's degree in electrical engineering. He is a licensed professional engineer in the state of New Jersey.

E. E. Parker (M '49), manager, research application services department of General Electric Company's Research Laboratory, has been appointed general manager of General Electric's instrument department. A native of Albany, Oreg., Mr. Parker was graduated from Oregon State College in 1931 and, the same year, joined General Electric as a student engineer. Following service on the general and advanced engineering programs, he was transferred to the Turbine Engineering Division where, in 1949, he was appointed division engineer. In March 1952, Mr. Parker became manager of the design engineering services department in the company's Engineering Services Division. He was named manager of the research application services department of General Electric's research laboratory in October 1953. He is a member of The American Society of Mechanical Engineers and the New York State Society of Professional Engineers.

O. B. Falls, Jr. (AM '39, M '45), manager of electric utility sales for the General Electric Company's Apparatus Sales Division, has been named manager of the atomic power equipment marketing study of General Electric's Atomic Products Division. Mr. Falls also has served as manager of product sales of the company's Pacific Northwest district at Seattle, Wash., and as a central station application engineer in the Pacific Northwest district. A native of Texas, he received a bachelor of science degree in physics and mathematics in 1934 at the University of Richmond, Richmond, Va., and both a bachelor's and master's degree in electrical engineering in 1936 at the Massachusetts Institute of Technology. Mr. Falls began work with General Electric on test work at Pittsfield, Mass., and at Schenectady, N.Y. Later he worked 2 years in the Transformer Division, Pittsfield, before being assigned to the electric utility engineering department at Schenectady. He transferred in 1948 to Seattle, Wash., as a central station application engineer.

G. A. Menard (AM '43, M '51), vice-president and general manager, Memco Engineering and Manufacturing Company, Inc., Commack, N.Y., since 1948, retired April 30. He retired from the General Electric Company switchgear department in 1948. He had been with General Electric in Schenectady, N.Y., Baltimore, Md., and Philadelphia, Pa., since 1916. After graduating as a civil engineer in 1910 from Rensselaer Polytechnic Institute, he had served in an engineering capacity on several construction projects such as the Mohawk Hydroelectric development, Cape Cod Canal railroad and highway relocation, New York connecting railroad viaduct, and Hell Gate Bridge foundations. He will now be associated with George Menard, Jr., Philadelphia, Pa., in suburban real estate development.

J. F. Houdek, Jr. (M '51), section head, research laboratory, Kellogg Switchboard and Supply Company, a division of International Telephone and Telegraph Corporation, Chicago, Ill., has been named chief of the general laboratory, Kellogg Switchboard. Mr. Houdek served as section head of the research laboratory since 1951. Previous to that, he was supervisor of the telephone research and development group of the company. A graduate of the Lewis Institute of Chicago (now the Illinois Institute of Technology), Mr. Houdek has completed graduate work in industrial engineering and management and allied fields at the University of Chicago and the Illinois Institute of

Technology. He is a founder and treasurer of the Chicago acoustical and audio group, and holds membership in the Armed Forces Communications Association and the Physics Club of Chicago.

C. E. Rettig (AM '50), engineer, General Electric Company, Schenectady, N. Y., has been named specialist, power electronics, in the industrial and transmitting tube subdepartment of General Electric in Schenectady. He served with the U. S. Naval Air Force for 3 years before beginning his career at General Electric as a Massachusetts Institute of Technology co-operative student. He has also held posts in power rectifier special test of the industrial engineering department and as a development engineer in power electronics. He has been on the Electronic Power Converters Committee of AIEE (1954–55).

Floyd Fellows (M '44), consulting industrial power engineer with the C. H. Stevens Company, New York, N. Y., for more than 18 years, is now with the Vanadium Corporation of America, New York, N. Y. He has been specially assigned to the company's engineering department at Niagara Falls, N. Y. The C. H. Stevens Company which had operated for more than 25 years was dissolved after the recent death of Mr. Stevens.

J. B. Castle (AM '50), factory sales manager, S & C Electric Company, Chicago, Ill., has been promoted to sales manager for fuses and interrupters. He will be responsible for all marketing aspects of those product lines. Mr. Castle came to S&C in 1953 as an application engineer after being associated with the electrical section of the Aluminum Company of America.

C. R. Miannay (AM '51), Merck and Company, Inc., Rahway, N. J., has joined the engineering staff of Esso Research and Engineering Company. Mr. Miannay received his bachelor's degree in electrical engineering from Clarkson College, and his master's degree in business administration from Rutgers University.

Walter Evan-Jones (AM'46), assistant sales supervisor, Commercial Products Division, Canadian Marconi Company, Montreal, Que., Canada, is now with the Canadian Westinghouse Company, Ltd., Electronics Division. He is responsible for the sales engineering promotion of the company's communication products across Canada. He has been actively engaged in the communication engineering fields for the past 15 years. Prior to his work with Canadian Marconi, he was with the communications group, Hydro-Electric Power Commission of Ontario, and the Northern Electric Company, Ltd. He is an associate member of the Institute of Radio Engineers.

M. L. Almquist (AM'23, F'51), transmission engineer, **P. W. Blye** (AM'27, F'51), transmission systems engineer, **F. J. Singer** (AM'36, F'51), switching development engineer, Bell Telephone Laboratories, Inc., New York, N. Y., and **R. R. Hough** (AM'41), member of Bell's technical staff, Whippany, N. J., have been named new general department heads. In the area of expanded systems engineering, Mr. Almquist is now director of systems engineering I, Mr. Blye is director of systems engineering II, Mr. Singer is director of systems engineering III, and Mr. Hough is director of military electronics development II in the area of work for the Armed Forces. Mr. Blye has served on the Institute's Standards Committee (1944–46) and Transmission and Distribution Committee (1949–51).

OBITUARIES

Clare Anderson (AM '26, M '37), with Roller-Smith Division, Realty and Industrial Corporation, Bethlehem, Pa., died recently. He was born in Timmonsville, S. C., February 25, 1900, and was a graduate of Bliss Electrical School. Most of his career was spent with the Westinghouse Electric Corporation. From 1918–20 he was with the Westinghouse testing department. He was employed by the supply engineering department in 1924. He spent 2 years as resident engineer in the electrification of the Milwaukee Railroad in the 1920's in connection with the new frequency telemetering maximum demand system. Subsequently, he spent 2 years as resident engineer in the electrification of the Chilean state railways in South America. During 1929 and 1930 he was the resident engineer representing the Westinghouse Corporation at the Siemens Schukert Works in Germany. On his return from Germany in 1930, he became section manager of the oscillograph section, and later was made division manager of the instrument and oscillograph engineering departments. In 1935 he transferred to the instrument application engineering department of the Westinghouse Corporation. He spent several years as an instrument engineer with the Roller Smith Company and also with the De Jur Amsco Company. His later years were spent on consulting work on instrument development and application problems and in developing several unique instrument devices on which he held patents. He was a member of the Montclair Society of Engineers (New Jersey) and a registered professional engineer in the state of New Jersey.

John B. Klumpp (AM '02, M '12, F '13, Member for Life), consulting engineer, Philadelphia, Pa., died recently. A graduate of Stevens Institute of Technology in 1894, he had been employed by The United Gas Improvement Company (UGI) until 1929 when he entered private practice as a consulting engineer. During his UGI employment he had charge of the operation and construction of gas properties owned by the company in various cities throughout the country. At the time of his resignation he was a vice-president. Prior to and after becoming a private consulting engineer, he served as a gas and electric consulting expert for the National Civic Federation; as a witness on gas standards and rates before many state public utility commissions, and with the U.S. Bureau of Standards, and as a consultant for the Counsel of National Defense during World War I. In addition, since 1930 he had been the consulting engineer to the Municipal Gas Commission of Philadelphia, in connection with the operation of the Philadelphia Gas Works. Included also in his activities were his assignment as consultant for the Minister of Development in the cabinet of the President of Venezuela; employment by many large utility, industrial, steel, and insurance companies on special reports. More recently he had been consulting engineer to Ozone Processes Inc., of Philadelphia, designing and installing water purification systems for municipal and private companies. He was active in the affairs of the American Gas Association (AGA) and of its predecessor utility associations, having been AGA president in 1924. He represented that association in many capacities before state and national bodies. He was a member of The American Society of Mechanical Engineers, past president of the Society of Gas Lighting, a member of the Franklin Institute, and of the Institution of Gas Engineers of Great Britain. Mr. Klumpp also worked on the Research Committee of AIEE (1921–23).

L. E. Emerich (AM '24), director of marketing for Leeds and Northrup Company, died May 5. Born in Schuylkill Haven, Pa., he attended Tamaqua High School and graduated from Carnegie Institute of Technology in 1922 with the degree of bachelor of science. While in college he carried out special work in physics research, and served in the U. S. Naval Reserve from 1918 to 1922. After a few months in the electric lighting field, he joined Leeds and Northrup in 1922 as a sales engineer. Later he opened the company's San Francisco, Calif., office and was manager there and in the Chicago, Ill., office until 1936. He went to the Philadelphia, Pa., office as assistant manager of technical sales and later was named manager of that division. In 1951 he became manager of market development and 3 years later became director of marketing and a member of the Leeds and Northrup executive committee. He was a member of the Instrument Society of America and the Engineers Club of Philadelphia.

Allerton Frank Brooks (AM '24, M '44, F '50), board chairman and former president of The Southern New England Telephone Company, New Haven, Conn., died on his 65th birthday, on April 12, while vacationing in Seville, Spain. Born in Meriden, Conn., Mr. Brooks graduated from the Sheffield Scientific School of Yale University in 1911. His entire business career was with The Southern New England Telephone Company, where he started as engineer's assistant in 1911. He served successively as supervisor of central office installations, special commercial agent, commercial engineer, and cost and appraisal engineer. In 1917 he took military leave of absence for service as a cadet in the Aviation Training Corps. Returning to the engineering department, he was promoted to plant extension engineer in 1926, chief engineer in 1927, and vice-president and general manager in 1930. He was elected president of the company in 1941, and held that post until last December, when he was elected chairman of the board. Mr. Brooks had served as a director of the Phoenix Mutual Life In-

surance Company, the New York, New Haven and Hartford Railroad, and several other concerns. He was an associate fellow of Calhoun College at Yale, a member of the Yale Alumni Board, and a trustee and executive committee member of Connecticut College at New London. He was a member of the Yale Club of New York, the Yale Engineering Society of New York, and various organizations in New Haven. He served on the Communication Committee of AIEE (1930–31).

Alanson Niles Topping (AM'05, M'12, Member for Life), professor emeritus of electrical engineering, Purdue University, Lafayette, Ind., died last May. Mr. Topping was born at Lawrence, Kans., December 24, 1871. He was an electrical engineering graduate of the University of Kansas. He joined the Purdue faculty as an instructor in electrical engineering. He had also taught for 6 years in the Lawrence High School and 2 years in the Kansas City High School.

Lewis H. Johnson (M'20, Member for Life), Rockland, Maine, died recently. He was born May 11, 1886. He attended the public schools of Rockland and was an electrical engineering graduate of Massachusetts Institute of Technology in 1909. After graduation he joined the Western Electric Company and was enrolled in the student course of the company. The following year he transferred to the Bell Telephone Company's circuit laboratory. He was in charge of local signaling development from early 1946 until June 1947 and then engaged in consultation work. He retired from the Bell Telephone Laboratories, Inc., systems development department in 1948.

Hubert Sharp (AM'25, M'31, F'51), radio engineer for the Mountain States Telephone and Telegraph Company, Denver, Colo., died April 16. He was born October 4, 1898, near Phoenix, Ariz. He received a degree in electrical engineering in 1921 from the University of California, and joined the Mountain States Telephone and Telegraph Company in El Paso, Tex. In 1924, he was transferred to the general engineering department at Denver and assigned to the staff of the electrical engineer. Mr. Sharp served as transmission engineer until 1934, then as protection engineer until 1947, when he was promoted to radio engineer on the staff of the chief engineer. In this assignment, he was instrumental in the wide-spread application of vhf radio for point-to-point telephone service in the Mountain States area, and in the application of short-haul microwave radio for telephone message and leased services. He was a member of the Colorado Engineering Council, the Technic Club of Denver, and a senior member of the Institute of Radio Engineers. During the past 30 years, he served the Denver Section of AIEE in various capacities, including secretary-treasurer (1940–43), vice-chairman (1943–44), and chairman (1944–45), and 8 years as a member of the Section's executive committee. As secretary and then chairman of the Section's history committee, he was responsible for collecting data and writing the history of the Denver Section. His services to the Institute include membership on the Electronics Committee (1949–50) and Committee on Radio Communications Systems (1951–55).

MEMBERSHIP • • •

Recommended for Transfer

The Board of Examiners at its meeting June 16, 1955, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

To Grade of Member

Archbold, E. J., asst. chief engineer, Georgia Power Co., Atlanta, Ga.
Arthur, G. M., chief electrical engineer, Fitchburg Engineering Corp., Fitchburg, Mass.
Bechtold, D. J., chief engineer, Northern Pennsylvania Power Co., Towanda, Pa.
Bender, T. D., supervising engineer, Boeing Airplane Co., Seattle, Wash.
Bolton, F. D., president, F. D. Bolton, Ltd., Vancouver, B.C., Canada
Bouska, J. G., Denver branch manager, The Electric Storage Battery Co., Denver, Colo.
Byron, T. J., retired, 1 Frear Ave., Troy, N.Y.
Carter, D. F., partner, Vinson-Carter Electric Co., Phoenix, Ariz.
Chadwick, J. W., Jr., electrical engineer, Tennessee Valley Authority, Bowling Green, Ky.
Collins, T., supt., T&D maintenance dept., B.C. Electric Co. Ltd., Vancouver, B.C., Canada
Crick, P. A., district manager, General Electric Co., Dallas, Tex.
D'Entremont, F. R., consulting engineer, General Electric Co., Lynn, Mass.
Dinkel, S. G., manager engineering, New Orleans office, General Electric Co., New Orleans, La.
Engster, F. W., manager, electric utility dept., General Electric Co., New Haven, Conn.
Floberg, V. A., electrical engineer, light dept., City of Tacoma, Wash.
Gable, J. G., manager electric governor project, Westinghouse Electric Corp., Buffalo, N. Y.
George, H. C., staff engineer, Detroit Edison Co., Detroit, Mich.
Goff, L. E., Jr., development engineer, General Electric Co., Philadelphia, Pa.
Goggins, J. W., electrical engineer, United Engineering & Foundry Co., Pittsburgh, Pa.
Gord, C.M., electrical engineer, light dept., City of Tacoma, Wash.
Greagan, J. J., Jr., asst. to president, Pneumafil Corp., Charlotte, N. C.
Green, D. B., chairman, electrical engineering dept., Ohio University, Athens, Ohio
Hargett, Y. S., engineer, General Electric Co., Schenectady, N. Y.
Hatley, M. T., Jr., engineer, Duke Power Co., Charlotte, N. C.
Henschel, W., assistant electrical engineer, The Port of New York Authority, New York, N. Y.
Hess, A. F., motor vehicle supervisor, American Tel. & Tel. Co., New York, N. Y.
Hogue, T. J., Jr., exchange plant engineer, Southern Bell Tel. Tel. Co., New Orleans, La.
Howard, D. R., electrical engineer, Columbus & Southern Ohio Electric Co., Columbus, Ohio
Hufnagel, H. M., senior electrical engineer, Rust Engineering Co., Pittsburgh, Pa.
Irwin, R. A., electronic division manager, Westinghouse Electric Corp., Washington, D. C.
Johnston, R. J., Jr., project engineer, AC Spark Plug Div., GMC., Flint, Mich.
Johnstone, J. W., Jr., electrical engineer, Day & Zimmermann, Inc., Philadelphia, Pa.
Keeler, O. F., Jr., engineering director & vice-pres., John I. Thompson & Co., Washington, D. C.
Keezer, D. C., electrical engineer, Pacific Gas & Electric Co., San Francisco, Calif.
Kenny, W. E., maintenance engineer, British Columbia Power Commission, Nanaimo, B.C., Canada
Kern, R. E., head servomechanisms engineer, Emerson Electric Mfg. Co., St. Louis, Mo.
Kline, R. H., supervisory field service engineer, Westinghouse Electric Corp., Baltimore, Md.
Krook, P. M., supervisory engineer, The Austin Co., Seattle, Wash.
Kups, E. F., supervisory electronic engineer, Rome Air Development Center, Griffiss AFB, N. Y.
Landgren, G. L., engineer, Commonwealth Edison Co., Chicago, Ill.
Leet, C. H., asst. branch manager, The Electric Storage Battery Co., Chicago, Ill.
Lewis, R. S., chief electrical operator, Belle Isle station, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Lillie, H., president, Alliance Engineering Co., Ltd., Vancouver, B.C., Canada
Locke, F. S., technical engineer, General Electric Co., Schenectady, N. Y.
Long, C. A., design engineer, Westinghouse Electric Corp., Sharon, Pa.
Lusia, P. A., industrial control engineer, Westinghouse Electric Corp., Boston, Mass.
Lynd, J. M., director, utilities div., USN., 14th ND Pearl Harbor, Territory of Hawaii
Makuh, G., vice-president & chief engineer, King Electric Equipment Co., Cleveland, Ohio
Manning, W. B., Jr., project engineer, Reynolds Metals Co., Malvern, Ark.
Manzi, A. P., president-treasurer, Manzi Electrical Corp., Lawrence, Mass.
Mayer, R. L., communications engineer, Pacific Gas & Electric Co., San Francisco, Calif.
McDonough, T. J., system design engineer, Rural Electrification Administration, Washington, D. C.
McKee, J. L., engineer, American Tel. & Tel. Co., New York, N. Y.
McWhirter, J. H., design engineer, Westinghouse Electric Corp., Sharon, Pa.
Medlin, H. L., senior engineer, Southwestern Bell Telephone Co., Dallas, Tex.
Mehrtens, H. A., engineer, Consolidated Edison Co. of N.Y., Inc., New York, N. Y.
Minor, A. F., engineer, American Tel. & Tel. Co., New York, N. Y.
Mirza, K. K., meter & test superintendent, Baghdad Light & Power Co., Ltd., Baghdad, Iraq
Moran, J. E., distribution engineer, Kentucky Power Co., Ashland, Ky.
Mosa, W. M., research associate, Woods Hole Oceanographic Institution, Woods Hole, Mass.
Munday, E. L., asst. to district manager, Appalachian Electric Power Co., Roanoke, Va.
Nichols, W. J., asst. section engineer, Rural Electrification Administration, Washington, D. C.
Olson, M. P., electrical engineer, Ebasco Services, Inc., New York, N. Y.
Oprendek, F. J., field engineer, Line Material Co., Pittsburgh, Pa.
Pesagno, T. S., project engineer, Western Union Telegraph Co., New York, N. Y.
Piazza, F. D., industrial sales mgr., Pennsylvania Electric Co., Johnstown, Pa.
Randall, H. L., research engineer, Boeing Airplane Co., Seattle, Wash.
Rempet, E. H., chief engineer, Mountain States Tel. & Tel. Co., Cheyenne, Wyo.
Riddle, A., design engineer, B.C. Engineering Co., Vancouver, B.C., Canada
Robbins, R. G., vice-pres. & general sales manager, Hubbard & Co., Pittsburgh, Pa.
Roberts, D. S., engineer, General Electric Co., West Lynn, Mass.
Rosenberg, A. E., senior design engineer, Ford Instrument Co., Long Island City, N. Y.
Schaeffer, H. A., Jr., plant engineer, The Flintkote Co., New Orleans, La.
Shatswell, M. H., Jr., senior engineer, Barber-Colman Co., Rockford, Ill.
Shumaker, J. L., staff supervisor, The Chesapeake & Potomac Tel. Co., Washington, D. C.
Simmons, H. O., Jr., sponsor engineer, General Electric Co., Schenectady, N. Y.
Staff, C. H., squad chief, electrical design sec., Weyerhaeuser Timber Co., Tacoma, Wash.
Steinbrucker, F. G., senior project engineer, Burns & Roe, Inc., New York, N. Y.
Sterrett, D. H., engineer, Duke Power Co., Charlotte, N. C.
Straight, A. L., engineer, Blackstone Valley Gas & Electric Co., Pawtucket, R. I.
Thompson, T. B., asst. professor, Oklahoma A & M College, Stillwater, Okla.
Turner, E. M., electronics engineer, Wright Patterson AFB, Dayton, Ohio
Ullman, R. D., electrical engineer, White Sands Proving Ground, N. Mex.
Walker, A. S., vice-pres., New England Power Co., Boston, Mass.
Ward, J. W., group engineer, Boeing Airplane Co., Seattle, Wash.
Weber, H. A., director, development & production, U. S. Atomic Energy Commission, Albuquerque, N. Mex.
Winsor, H. J., electrical engineer, light dept., City of Tacoma, Wash.
Yagerhofer, F. C., electrical engineer, Naval Research Laboratories, Washington, D. C.
Yeide, H. E., manager, distribution dept., Potomac Electric Power Co., Washington, D. C.

89 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member, have been received from the following candidates, and any member objecting to election should supply a signed statement to the Secretary before August 25, 1955, or October 25, 1955, if the applicant resides outside of the United States, Canada, or Mexico

To Grade of Member

Bogan, C. W., C. W. Bogan & Associates, Washington, D. C.
Friedman, T. B., Adler Communications Labs., New Rochelle, N. Y.
Lloyd, C. G., General Electric Company, Syracuse, N.Y.
McRae, J. W., Sandia Corp., Albuquerque, N. Mex.
Park, J. G. (re-election), Eastern Electricity Board, London, England
Payne, A. H., Jr., Payne Engineering Co., Birmingham, Ala.
Piore, E. R., Avco Mfg. Corp., New York, N. Y.
Shaffer, M. J., Govt. of Singapore, Singapore, Straits Settlements
Stearns, H. M., Varian Associates, Palo Alto, Calif.

9 to grade of Member

Report of the Board of Directors

THE BOARD OF DIRECTORS of the American Institute of Electrical Engineers presents to the membership its 71st Annual Report, covering the fiscal year ending April 30, 1955. It contains a brief summary of the principal activities of the Institute during the year, a general balance sheet showing the financial condition of the Institute at the close of the fiscal year, a statement of cash receipts and disbursements, and a schedule of securities owned. Much additional information regarding the activities appeared in various issues of *Electrical Engineering*.

BOARD OF DIRECTORS' MEETINGS

Five meetings of the Board of Directors were held during the year, one in New York, N.Y., and one each in Los Angeles, Calif.; Pittsburgh, Pa.; Chicago, Ill.; and St. Petersburg, Fla.

Information regarding many of the more important matters which were considered by the Board of Directors appeared in various issues of *Electrical Engineering*.

ANNUAL MEETING

The 70th annual business meeting of the Institute was held in Los Angeles, Calif., June 21, 1954. A brief abstract of the Annual Report of the Board of Directors for the fiscal year ended April 30, 1954, was presented by Secretary N. S. Hibshman, who also gave a résumé of a report by Walter J. Barrett, Treasurer, on Institute finances.

The report of the Committee of Tellers on the vote of the membership on the election of officers whose terms were to begin on August 1, 1954, was presented by Secretary Hibshman. President Robertson presented a President's badge to A. C. Monteith, who responded by thanking the members for their confidence in him, and giving a brief address on Institute progress.

President Robertson presented a certificate of honorary membership in the Institute to Dr. R. W. Sorensen.

The Lamme Medal for 1953 was presented to F. A. Cowan, American Telephone and Telegraph Company, New York, N. Y.

President Robertson gave an address on "The Year's Achievements."

Mr. Robertson introduced Past President McMillan who spoke of the past 22 years during which Henry H. Henline had served the Institute as Secretary. Professor McMillan had requested the past presidents who held office during the retiring secretary's regime to write letters of appreciation to Mr. Henline. Excerpts were read from 15 of these letters which were presented to Mr. Henline together with a pair of binoculars.

GENERAL MEETINGS

Three General meetings were held during the year, and a brief report on each follows:

Summer and Pacific General Meeting. The 70th Summer General Meeting combined with the Pacific General Meeting was held in Los Angeles, Calif., June 21–25, 1954, with a registration of 2,069.

There were 56 technical sessions at which 237 papers were presented, a management session with two papers, a session on safety with four papers, a session on nuclear reactors, the annual meeting, a District 8 Branch paper competition, a Section delegates conference, meeting of the Board of Directors, meetings of many committees, numerous attractive inspection trips, several luncheons with speakers, President's reception and dinner, various entertainment events, and many events for the ladies. (*EE, Aug '54, pp. 738–45*)

Fall General Meeting. The eighth Fall General Meeting was held in Chicago, Ill., October 11–15, 1954, with a registration of 2,026, the largest to date. In 54 sessions, 234 papers were presented. In addition, there was a general session, a session on management, a safety session, eight sessions on air transportation, a meeting of the Board of Directors, various committee meetings, many inspection trips, a smoker, dinner-dance, and an elaborate schedule of events for the ladies. (*EE, Dec '54, pp. 1121–3*)

Winter General Meeting. The Winter General Meeting was held in the Hotels Statler and Governor Clinton, New York, N.Y., January 31–February 4, 1955, with a registration of 4,652. There were 88 sessions at which 396 papers were presented, a general session, two special medal presentation sessions, a session on the engineering code of ethics, a management session, a session on how the utilities can best make use of modern science, a session on preventing fires from electrical causes, a forum of technical committee chairmen, a Section delegates conference, meeting of the Board of Directors, various committee meetings, stag smoker, dinner-dance, many inspection trips, and events for the ladies. (*EE, Mar '55, pp. 245–51*)

DISTRICT MEETINGS

North Eastern District Meeting (1954). A meeting was held in Schenectady, N. Y., May 5–7, 1954, with a registration of 870. There were a general session, 16 technical sessions with 68 papers, a conference on nucleonics, buffet supper, smoker, inspection trips, and ladies' events. A meeting of the North Eastern District Executive Committee was held on May 4. (*EE, Jul '54, pp. 661–3*)

Middle Eastern District Meeting (1954). This District held a meeting in Reading, Pa., October 5–7, 1954, with a registration of 905. The program included a general session, 20 technical sessions with 74 papers, two sessions on textiles and a luncheon, a Student luncheon, District Executive Committee meeting, luncheons, banquet, inspection trips, and ladies' activities. (*EE, Dec '54, pp. 1125–6*)

Southern District Meeting (1955). This meeting was held in St. Petersburg, Fla., April 13–15, 1955, with a registration of 476. There were a general session, 20 technical sessions with 75 papers, a special session on poles and aluminum connectors, a Student conference, a District Executive Committee meeting, two general luncheons, dinner-dance, sightseeing trips, and ladies' activities. (*EE, June '55, pp. 532–5*)

SPECIAL TECHNICAL CONFERENCES

Nineteen Special Technical Conferences were held during the year ending April 30, 1955. Eight were jointly sponsored in cooperation with other societies. AIEE sponsorship is by the technical committees in co-operation with the local Sections. In the aggregate 7,500 people attended these conferences and over 375 papers were presented. Brief summary reports follow.

Military Communications Conference. This conference, sponsored by the AIEE Communications Division and the Institute of Radio Engineers' Professional Group on Communications Systems, was held in New York City on April 28, 1954, with an attendance of approximately 300. Ten papers were presented on subjects including *ANTRC-24* radio relay, *TCC* carrier telephone, and *FGC-29* multichannel carrier telegraph equipments. There was an inspection of the *ANTRC-24* and *TCC* equipment. Conference proceedings were not published.

Electronics Components and Materials Conference. The fifth national Conference on Electronics Components and Materials was held in Washington, D. C., May 4–6, 1954. It was jointly sponsored by AIEE, Institute of Radio Engineers (IRE), Radio-Electronics-Television Manufacturers Association, and the West Coast Electronic Manufacturers Association, in participation with agencies of the Department of Defense and the National Bureau of Standards, and was attended by more than 1,100 engineers and equipment designers from all parts of the United States and Canada. There were five general papers given at the opening session and 36 papers presented at the six technical sessions. One of the papers presented at a session was a survey of European component development. Conference proceedings were published. (*EE, Jul '54, pp. 664–6*)

Appliance Technical Conference. Some 220 engineers attended this conference at the Morrison Hotel, Chicago, Ill., May 17–19, 1954, which was sponsored by the AIEE Committee on Domestic and Commercial Applications. The Chicago Section acted as host. The theme was "Performance Testing and Standardization" and the program was directed toward all the interests in the appliance industry. Registrants included representatives from a number of utilities and approvals laboratories, together with representatives of 50 manufacturers. Inspection trips were conducted to the Underwriters' Laboratories; the Range and Refrigerator plants of Hotpoint, Inc.; Dole Valve Com-

pany; Birtman Electric Company; and Sears-Roebuck Appliance Testing Laboratories. No proceedings were published. (*EE, Jul'54, pp. 667–8*)

Electric Welding Conference. The fourth AIEE Conference on Electric Welding was held at Milwaukee, Wis., for 3 days, May 19–21, 1954. It was sponsored by the AIEE Committee on Electric Welding, in co-operation with the Milwaukee Section and the American Welding Society. Some 214 attended with the greater number representing outstanding leaders in the field of arc and resistance welding. Nineteen papers were presented during the five sessions covering fields of inert gas arc, fundamental arc research, safety, instrumentation, and resistance welding. There were four plant tours in the Milwaukee area at A. O. Smith Corporation, Cutler-Hammer, Inc., Square D Company, and Nash Motors Division of Nash Kelvinator Corporation, which were all well attended. A conference proceedings booklet was published and is available at AIEE Headquarters. (*EE, Jul'54, p. 671*)

Conference on Telemetering. A 3-day conference, jointly sponsored by AIEE, IRE, Institute of Aeronautical Sciences, and the Instrument Society of America (ISA), was held in Chicago on May 24–26, which covered the application of automatic measuring for guided control, analogue computers, and remote control of helicopters. There were six papers on telemetering systems, six on telemetering pickups and components, an evening workshop on classification of telemetering systems, four papers on remote control using digital computers, five on remote control using analogue computers. three on all-weather flight control, and five on information handling and data reduction in radio and flight control. Some 305 engineers and others attended the conference. A conference proceedings was published.

Conference on Petroleum Industry. With 389 engineers from 22 states and Canada attending, the first Petroleum Conference was held in Tulsa, Okla., on September 27–29, 1954, with the Tulsa and Oklahoma City Sections as host. Nineteen papers were presented during the five technical sessions covering applications in production of oil and gas, pipe-line subjects, refining applications; also included were a general session and an evening session with banquet. AIEE President Monteith was the principal speaker at the conference. Mimeographed copies of the papers were made available for distribution. (*EE, Dec'54, pp. 1123–4*)

Machine Tool Conference. The seventh annual AIEE Machine Tool Conference was held in Detroit, Mich., October 25–27, 1954, with an attendance of 600 engineers. It was sponsored by the Subcommittee on Machine Tools of the General Industry Applications Committee, with the Detroit Section acting as host. Eight papers were presented on automation. preventative maintenance, electronic controls, and a panel discussion on electric clutches was featured. No proceedings were published. (*EE, Dec '54, pp. 1129–30*)

Mid-Atlantic Textile Conference. Over 200 electrical engineers, plant engineers, and textile mill representatives attended this conference in Raleigh, N. C., November 4–5, 1954, at the North Carolina State College. A tour of the School of Textiles took place before the session started on the first morning. Eight papers were presented during the three sessions, with an evening social hour and barbecue dinner, and a panel discussion on "Electrical Problems and Their Remedies." No proceedings were published. (*EE, Jan'55, p. 77*)

Conference on Electrical Techniques in Medicine and Biology. This conference was held in Chicago at the Morrison Hotel, November 10–12, 1954, and was jointly sponsored by AIEE, IRE, and ISA. It was the seventh annual conference on the subject and attended by more than 150 electrical engineers, electronic experts, researchers in the fields of medicine, biology, and biophysics. Fourteen papers were presented at the three sessions, with two trips to the Argonne Cancer Hospital and the Argonne National Laboratory which were well attended. No proceedings of the conference were published. (*EE, Jan'55, p. 76*)

Eastern Joint Computer Conference and Exhibition. The 1954 Eastern Joint Computer Conference and Exhibition attracted a registration of over 1,750 engineers and others in the computer field. It was jointly sponsored by AIEE, the IRE, and the Association for Computing Machinery, and was held in Philadelphia, December 8–10, 1954. Twenty-one papers were presented during the six sessions. Panel discussions and a reception and cocktail party were part of the accompanying activity. There were inspection trips which were well attended, as were the exhibits of more than 40 companies. Proceedings were published and may be obtained from any of the sponsoring societies. (*EE, Feb'55, p. 159*)

Conference on High-Frequency Measurements. The fourth conference on this subject was held in Washington, D. C., January 17–19, 1955, with an attendance of 350. There were four technical sessions, at which 24 papers were presented. It was sponsored by AIEE, IRE, the National Bureau of Standards, and the International Scientific Radio Union (URSI). There were inspection trips to four Government laboratories, a cocktail party, and a group luncheon at which Hon. D. A. Quarles, Assistant Secretary of Defense for Research and Development and past president of AIEE, was the speaker. Copies of papers brought by authors and abstracts of papers were distributed at the conference. No proceedings were published. (*EE, Mar'55, p. 250*)

Conference on Transistor Circuits. Nineteen papers were presented in the four sessions at this conference held in Philadelphia, February 17–18, 1955, which was attended by approximately 700 engineers. It was jointly sponsored by AIEE, IRE, and in co-operation with the University of Pennsylvania. Following the cocktail buffet party, five informal discussion groups were organized on subjects suggested by engineers attending. Interest was so great that it is planned to make it an important scheduled event. Abstracts of papers were included in the program. No proceedings were published. (*EE, Apr'55, p. 348*)

Southern Textile Conference. This conference was held at the A. French Textile School of the Georgia Institute of Technology, Atlanta, Ga., on March 3–4, 1955, with a total registration of 126. It was sponsored by the Subcommittee on Textile Industry of the Committee on General Industry Applications. Eight papers were presented during the three sessions in addition to a panel discussion on "Mill Electrical Problems" and a social hour and banquet. The 1956 Georgia meeting was tentatively outlined along the lines of having both National Electrical Manufacturers Association representatives and subcommittee panel members represented to outline the work that has been done on electrical enclosures, methods of operation, and other pertinent electrical data. No proceedings were published. (*EE, June '55, p. 538*)

Conference on Farm Electrification. This conference was held in Chicago, March 8–10, 1955, and was sponsored by the AIEE Farm Electrification Subcommittee of the Committee on Domestic and Commercial Applications. The Chicago Section acted as host to the conference. Some 211 attended, including people from 23 states and Canada. There were discussions on the latest developments regarding the use of electricity on present-day poultry, dairy, and livestock farms. There were visits to two modern electrified farms. No proceedings were published. (*EE, May '55, p. 434*)

Conference on Electrical Utilization of Aluminum. A successful conference on this subject was held in Pittsburgh on March 15–17, 1955, with an attendance of 585. Papers were presented covering the uses of aluminum in switchgear, transformers, regulators, reactors, rotating machines, cables, transmission and distribution conductors, and other miscellaneous applications. A banquet was held on the evening of the second day at which the president of the Aluminum Company of America spoke on "Man's Distinctive Mark." Inspection trips were made to the Westinghouse Electric Corporation, East Pittsburgh Works; Aluminum Company of America, Research and Development Laboratories, New Kensington; and Duquesne Light Company, Elrama Power Station. A proceedings of the conference will be published and may be obtained from AIEE Headquarters at $3.50 per copy. (*EE, June '55, pp. 357–8*)

Conference on Materials Handling (Electric Overhead Cranes). With 225 members and guests attending, the Conference on Electric Overhead Cranes was held in Cleveland, Ohio, March 28–29, 1955. It was sponsored by the Materials Handling Subcommittee of the AIEE General Industry Applications Committee. Eleven papers were presented covering the subjects of overhead traveling cranes, grab buckets, and collector systems. There was an inspection trip through the Cleveland Ford Engine Plant. A conference proceedings will be published at $3.00 per copy.

General Committees

BOARD OF EXAMINERS

The Board of Examiners followed its custom of meeting every month except August, and acted on 4,210 applications for admis-

Table I. Applications and Proposals Received by the Board of Examiners 1954–55

Admission		
Affiliate		
Recommended	319	
Not recommended	0	319
Associate Member		
Recommended	2,815	
Reinstated	1	
Re-elected	147	
Not recommended	83	3,046
Member		
Recommended	63	
Re-elected	15	
Not recommended	6	84
Total admission cases		3,449
Transfers		
Fellow		
Recommended	41	
Not recommended	0	41
Member		
Recommended	687	
Not recommended	24	711
Associate Member		
Recommended	8	
Not recommended	1	9
Total transfer cases		761
Total cases		4,210
Student member enrollment		3,880
Grand total		8,090

sion to the Institute or for transfer among the grades of membership. The figure may be compared with totals of 4,586 a year ago and 4,575 in 1952–53.

The Board's roster includes several members who travel considerable distances to attend meetings in New York, but is large enough to deal with its case load without monthly carry-over. Any delays in action are usually attributable to difficulties which the Board's secretary encounters in securing from the candidate or from proper references forthright statements as to a candidate's engineering status and achievements, as called for by the Constitution and Bylaws. Cooperation in this respect is improving and is appreciated.

The number of names submitted for election to Fellow grade during the year was 41, and the fact that all were recommended by the Examiners shows that the required qualifications are well understood throughout the Institute. Sponsors, however, have not been generally successful in drafting achievement citations accurately and concisely; hence it has been necessary for the Examiners to revise or reconstitute many of the citations. This is less desirable than if citations were precisely drawn locally by sponsor-references personally familiar with candidates' claims to regional or national distinction. *Electrical Engineering* now carries a sufficient number of citations each month to serve as models.

The figure of 41 Fellows transferred this year is comparable with that of 46 last year and 26 the year before. This plateau is considered desirably lower than the annual level of 70 to 90 or more obtained before Fellow elections were based upon sponsor-evaluated distinction rather than upon direct application. Nevertheless, attention of all Fellows and Members is directed to the fact that sole initiative rests with them to add to their number as Members attain professional distinction.

The Board has continued its task of investigating United States and foreign societies' professional requirements for membership to determine whether or not such societies are in fact constitutionally cognate with AIEE for purposes of membership-grade credits.

The Examiners joined with certain committees advocating Constitutional changes now before the membership, to facilitate transfer of Students to Associate Member grade in such a manner as to reduce the proportion of drop-outs following graduation.

The Board also advocated a Constitutional change permitting waiving, in certain instances, of the 2-year Associate Membership prerequisite to Member grade, it having been found in practice that the former sole criterion of membership in cognate national societies as a basis of waiver led to inequities.

The Examiners are continuing studies of changes in Bylaws which it will become desirable to recommend to the Board of Directors in the event that the membership approves shifting from Constitution to Bylaws the rules regarding membership-grade credit for licensed professional engineers.

COMMITTEE ON CODE OF PRINCIPLES OF PROFESSIONAL CONDUCT

The committee has sponsored conferences on the broad subject of ethics at the Winter General Meeting of the Institute in New York in January 1955, and at the Summer General Meeting in Swampscott in June. Also, another session on ethics was sponsored by the local Section at the Columbus, Ohio, meeting in May.

At these three conferences, speakers from other professional societies have been brought in, and discussions have been centered upon the need for, and the proper coverage of, engineering codes of ethics, in the light of present-day conditions. Out of this has grown the idea that the numerous and different codes of ethics that have been adopted by various engineering organizations should be collected and summarized in a brochure for the use of young engineers, and particularly for those receiving their engineering licenses, to bring home to them the importance and the nature of ethical codes that engineers have subscribed to.

It is the general feeling that very few engineers of the present day have more than a faint idea as to the importance of ethical codes, nor do they realize the many discrepancies which exist between the codes of the various societies. In spite of the fact that most engineering societies have subscribed to the Engineers' Council for Professional Development (ECPD) "Canons of Ethics," they continue to publish their own special codes.

It is hoped that out of these conferences and discussions a plan may be developed for joint action between the AIEE, the ECPD, and the National Society of Professional Engineers toward the preparation of the afore-mentioned brochure.

It is also hoped that the publication in *Electrical Engineering* of the principal talks given at these various conferences will lead to a better appreciation by Institute members of ethical codes, and a correspondingly greater effort by the members to live up to the highest ideals of the profession.

COMMITTEE ON CONSTITUTION AND BYLAWS

Within the year under review a number of proposals for changes in the Constitution and Bylaws of the Institute have been considered and reported on by the Committee on Constitution and Bylaws.

At the Los Angeles meeting of the Board of Directors, June 24, 1954, a recommendation of the Committee on Student Branches was approved in principle and referred to this committee for formulation for the code of the Institute. The amendments proposed were prepared and presented at the Pittsburgh meeting, August 12, 1954. The Board of Directors discussed the proposals and referred them to the Board of Examiners, as these proposals had to do with the early admission of graduating seniors in electrical engineering to the Associate Member grade. At the New York meeting, February 3, 1955, revised proposals were approved by the Board as suitable amendments.

At the Los Angeles meeting the Committee on Planning and Co-ordination presented a recommendation relative to the voting and office-holding privileges of Affiliates. Because of certain inconsistencies in both the Constitution and Bylaws this committee presented proposed changes designed to clarify the Constitutional statements. The problem was again before the Board at the Chicago meeting, October 10, 1954, and at the New York meeting, February 3. At the latter meeting this committee was requested to prepare amendments limiting the voting and particularly the office-holding privileges of Affiliates. Such proposed amendments have been prepared and were presented at the April meeting of the Board. These amendments involve both the Constitution and the Bylaws.

Certain other amendments have been prepared, presented to the Board, and approved by it:

1. Upon recommendation of the Board of Examiners an amendment to the Constitution permitting an applicant for Member grade to submit 3 additional years of approved engineering experience in lieu of the 2-year Associate Member requirement, has been approved by the Board for submission to the electorate of the Institute.

2. Another Constitutional amendment from the same committee permitting alternative qualifications for all grades of membership, except Fellow, was also approved by the Board.

3. On the recommendation of the Committee of Tellers, a minor Constitutional amendment to the voting procedures was approved by the Board.

4. A Bylaw amendment to Section *13* increasing the annual dues of corporate and Affiliate members, proposed by the Finance Committee, was reviewed by this committee and approved by the Board at its February meeting.

Additional amendments to the Bylaws have been prepared by this committee and were submitted to the Board of Directors at its April meeting. These are

1. An amendment to change the end of the budget year from September 30 to April 30, thus making the Institute's budget year and fiscal year coincide. This proposal was originally submitted by the Finance Committee.

2. Recommended by the Vice-President of District 2, the Board approved the subdivision of District 2 into a new District 2 and District 11. The recommendation was approved by the Board.

3. A recommendation by the Committee

on Student Branches relative to the formation of Affiliate Branches was approved in principle by the Board and this committee has prepared the necessary Bylaw changes to implement this proposal.

4. Based on a recommendation by the Committee on Student Branches this committee has prepared Bylaw amendments covering a plan to reduce the dues of Associate Members who are graduate students in accredited electrical engineering schools.

COMMITTEE ON EDUCATION

The Committee on Education held two meetings during the year, one at the Fall General Meeting in Chicago and one at the Winter General Meeting in New York. The committee also cosponsored a conference session at the Fall General Meeting and sponsored two sessions at the Winter General Meeting.

In co-operation with the Committee on Safety, a 4-paper session was staged in Chicago on the subject: "Safety in the College Laboratory." The primary objective was to reawaken laboratory instructors to the importance of teaching safety to engineering students.

At one of the sessions in New York, the committee undertook to familiarize Institute members with the recent work of the Committee on Evaluation of Engineering Education, a special project committee of the American Society for Engineering Education (ASEE). The ASEE committee was also anxious to obtain a reaction from practicing electrical engineers. The excellent audience and lively discussion produced mutually advantageous results. After the evaluation report was given, panel members discussed the implications of the recommended curricula changes as they pertained to the college electrical engineering department, to industry, and to professional registration.

The second New York session explored "The Place of Physics in the Electrical Engineering Curriculum." The four papers were authored and presented by two physicists and two electrical engineers. While there was some divergence of opinion as to who should teach physics and when, there was fair agreement as to what should be taught and how. This session attracted an unusually large audience and has led to requests for a similar treatment of mathematics in the electrical engineering curriculum.

A subcommittee is currently working with a subcommittee of the Committee on Management to explore the relative capabilities of technical institute graduates and engineering college graduates, and to make recommendations regarding most efficient utilization of both. The management problem of working toward optimum organizational balance is also being studied. It is hoped that this project will result in a cosponsored session at the next Fall General Meeting.

Another subcommittee is undertaking a study of co-operative engineering education at both the undergraduate and graduate levels. A report by this group is anticipated at the next Winter General Meeting.

FINANCE COMMITTEE

The statement of income and expenses appearing in this Report reflects that the unbalance in our financial position which first appeared as an excess of expenses over income in the auditor's report for the previous fiscal year was seriously augmented during the year just closed. This condition intensified the studies of the Institute officers and committees in evaluation of all services to members, as well as the search for further sources of income. The results of these studies, as conveyed to the membership in a recent series of articles appearing in *Electrical Engineering*, gave the Board of Directors, on recommendation by the Finance Committee, no further effective alternative but to raise annual dues.

Aside from the inteasive activities devoted to this study of income and expenses, the Finance Committee implemented several new procedures to simplify accounting practices. Chief among these was the change in the budget year, which formerly ended September 30, to correspond with the fiscal year. This required the adoption of a new budget to run concurrently with the fiscal year beginning May 1, 1955. On recommendation of the Finance Committee the new budget was approved by the Board of Directors at the April meeting. It will reflect a substantially improved financial position without impairment of the services of the Institute to its members.

The committee also simplified procedures with respect to security transactions by establishment of a custodial account with the National City Bank, which permits more efficient and expeditious service on the invested reserves. Other revisions in accounting practice and procedures, such as handling the payroll by weekly checks rather than in cash as formerly and the financing of Special Technical Conferences in the same way as General and District meetings, were also adopted.

COMMITTEE ON MANAGEMENT

The Committee on Management has sponsored a session at each of the General meetings and in addition a session was held at the Middle Eastern District Meeting. Interest in these sessions has continued high with excellent attendance and a number of papers were selected for general interest articles in *Electrical Engineering*. The committee met at the Fall General and the Winter General meetings. At the Fall General Meeting the principal discussion was the encouragement of management programs in the Section meetings. A subcommittee under the chairmanship of Mr. Langell was appointed to report on methods of encouraging such activity.

A subcommittee also met with the executive committee of The American Society of Mechanical Engineers (ASME) Management Division to become acquainted with their objective scope and organization. As a result of this subcommittee's report at the Winter General Meeting, it was the concensus that we should undertake to cosponsor with the ASME a session on management in 1956.

In view of the enlarged interest in the management program, a subcommittee was appointed to restudy the objectives of the committee and to present ideas for committee organization more adequately to meet enlarged objectives.

COMMITTEE ON MEMBERS-FOR-LIFE FUND

In accordance with recent practice a portion of the Members-for-Life Fund was used to defray in part the expenses of the winners of the Student District Paper competitions to the Summer General Meeting at Los Angeles. The fund increases by a significant amount each year and the present use of the fund in defraying the expenses of students to the Summer General Meeting utilizes less than half the current income. For example, the present capital value of the fund is $19,015.13, the current annual income is $3,715.30, of which $262.50 is from investments and $3,452.80 is from voluntary contributions. The maximum expected expenditure for traveling expenses is about $1,500. The committee held a meeting on February 2 at the Winter General Meeting at which it voted to recommend to the Board that the present practice of defraying part of the expenses of the winners of the Student District Paper competitions to the Summer General Meeting be continued for the coming year.

Inasmuch as it has been stipulated that the fund should not be allowed to build up to a large capital sum, the committee gave careful consideration to other useful projects to which the fund might be applied. It recognized the importance of encouraging still further student participation in Institute activities and requested the Committee on Student Branches to make recommendations as to further uses of the fund for student purposes. The committee has, therefore, deferred making further recommendations for the use of the fund for student purposes pending the recommendations of this committee.

In its vote of June 24, 1948, the Board approved the principle that the fund could "be used for prizes and other similar purposes." Taking into consideration this vote and the fact that the number of Institute medals is entirely inadequate to reward all those who merit recognition for their achievements, the committee voted to recommend that some of the fund be used for the establishing of one or more medals. The first medal would emphasize the field of education. The committee is now evolving the rules and procedure which are necessary to the establishing and administering of an Institute medal, and it also plans to give the medal a name. As soon as these plans are completed the committee will submit its recommendations to the proper Institute committees and to the Board for approval.

MEMBERSHIP COMMITTEE

As of April 30, 1955, membership in the Institute reached a new high of 48,993 members. This is an increase of 1,070 members over a similar figure of a year ago or a gain of 2.2 per cent. Table II, membership statistics, shows the distribution and the net changes among the various grades. It is interesting to note that the increase among the Affiliates was 40 per cent, resulting in a new high in that grade of 933 members.

Student membership increased to 7,666 from 6,904 as of last year and definitely marks the end of the decline in Student members experienced since 1950. The combined efforts of the Committee on Student Branches and the Sections Committee in encouraging students to become Student members are responsible for reversing this trend.

Table III indicates that during the year 3,589 applications were received of which 1,045 were from students and 2,544 from

Table II. Membership Statistics for Fiscal Year Ending April 30, 1955

	Honorary Members	Fellows	Members	6-Year Associate Members	Associate Members	Affiliates	Sub-totals	Totals
Membership April 30, 1954	4	1,507	10,947	13,073	21,725	667		47,923
Additions:								
New members qualified			52		2,207	292	2,551	
Former members reinstated or re-elected		1	34	96	173		304	
Subtotals		1	86	96	2,380	292	2,855	
Transfers	1	44	609	2,936	9		3,599	
Totals	1	45	695	3,032	2,389	292	6,454	
Deductions:								
Died		28	91	97	22	2	240	
Resigned		1	70	173	225	5	474	
Dropped		1	84	333	643	10	1,071	
Subtotals		30	245	603	890	17	1,785	
Transfers		1	44	532	3,013	9	3,599	
Totals		31	289	1,135	3,903	26	5,384	
Net Changes	1		14	406	1,897	−1,514	266	1,070
Membership April 30, 1955	5	1,521	11,353	14,970	20,211	933		48,993

Table III. Number of Applications Received From Student Members and From All Others

Year Ending April 30	Students	All Others	Total
1955	1,045	2,544	3,589
1954	1,157	2,547	3,704
1953	1,614	2,405	4,019
1952	2,591	2,430	5,021
1951	4,168	2,082	6,250
1950	4,033	2,417	6,450
1949	2,286	2,192	4,478
1948	1,481	2,272	3,753
1947	938	2,331	3,269
1946	308	2,453	2,761
1945	249	2,179	2,428
1944	466	1,908	2,374
1943	783	1,431	2,214

Table IV. Number of Student Members

Year Ending April 30	New Applications	Renewals	Total
1955	3,832	3,834	7,666
1954	3,571	3,333	6,904
1953	2,744	4,038	6,782
1952	3,023	5,834	8,857
1951	4,635	10,393	15,028
1950	7,876	12,792	20,668
1949	9,967	9,461	19,428
1948	7,876	6,041	13,917
1947	5,092	3,929	9,021
1946	2,574	2,513	5,087
1945	2,326	2,287	4,613
1944	2,242	2,656	4,898
1943	2,512	3,200	5,712

Table V. Record of AIEE Membership

Year	Total May 1	Year	Total May 1	Year	Total May 1
1884	71	1909	6,400	1933	17,010
1885	209	1910	6,681	1934	15,230
1886	250	1911	7,117	1935	14,269
1887	314	1912	7,459	1936	14,600
1889	333	1913	7,654	1937	14,600
1890	427	1914	7,876	1938	16,078
1891	541	1915	8,054	1939	16,605
1892	615	1916	8,202	1940	17,213
1893	673	1917	8,710	1941	17,886
1894	800	1918	9,282	1942	18,944
1895	944	1919	10,353	1943	20,161
1896	1,035	1920	11,345	1944	21,407
1897	1,073	1921	13,215	1945	23,072
1898	1,098	1922	14,263	1946	25,090
1899	1,133	1923	15,298	1947	26,470
1900	1,183	1924	16,455	1948	28,408
1901	1,260	1925	17,319	1949	30,791
1902	1,549	1926	18,158	1950	34,198
1903	2,229	1927	18,344	1951	38,058
1904	3,027	1928	18,265	1952	42,220
1905	3,460	1929	18,133	1953	45,426
1906	3,870	1930	18,003	1954	47,923
1907	4,521	1931	18,334	1955	48,993
1908	5,674	1932	18,003		

others. The applications received from other than students is practically the same as last year which was the highest on record. The decline in applications received since 1950 closely followed the trend set by Student membership totals. Now that the Student member totals are on the increase the Membership Committee is hopeful that the applications for Associate Membership from students will take a turn for the better and the decline in total applications received will be reversed.

Members in arrears for dues numbered 1,961 or 4.0 per cent; this is a slight improvement over the previous year when 1,969 or 4.1 per cent were delinquent.

The committee is especially appreciative of the co-operation and sincere efforts of the Student Branch Counselors, the members of the Section Membership Committees, and their chairmen for this continued growth of membership in the Institute.

COMMITTEE ON PLANNING AND CO-ORDINATION

During the administrative year, four meetings of the committee were scheduled; Chicago, October 12; New York, December 15, 1954; New York, February 1; Swampscott, June 26, 1955. The work was conducted under the following numbered assignments:

1. General and District Meeting Schedules. Faced with increasing difficulty of obtaining adequate hotel accommodations for the Summer General Meetings (at which the registration currently is 5 per cent of the membership), the committee decided to evolve a 5-year co-ordinated schedule for General and District meetings. A subcommittee (L. R. Gaty, chairman) was appointed to handle this assignment.

To relieve the Winter General Meeting of its increasingly heavy technical program (90-odd sessions in nine periods), the committee recommended (and the Directors approved) that Chicago be designated as the recurrent locale for the Fall General Meeting with occasional acceptance of invitations from other midwestern cities (e.g., Pittsburgh in 1958 during its bicentennial).

The Directors delegated to the committee authorization of location and dates of District meetings, and dates of General meetings for which the location had been approved previously.

The subcommittee is attempting to co-ordinate the Institute schedule of meetings with those of other related societies.

For authorized current schedule of future General and District meetings see pp. 714–15.

2. Redistricting of the Institute. The committee reviewed all the available correspondence proposing plans to increase the number of Districts in order to decrease the number of administrative units (Sections and Branches) which the Vice-Presidents are expected to visit annually.

Recognizing the impracticability of obtaining local approval of readjustment of present territorial lines to effect complete redistricting at one time, the committee recommended (and the Directors approved) division of those Districts which elect to divide.

Under this plan of local option, District 2 has chosen to divide itself, effective August 1, 1955, into District 2—Middle Eastern, and a new District 11—East Central (see p. 737).

The addition of District 11 and adjustment of Section territories has required revision of the map accompanying Bylaw 31

3. Questionnaire on Employment Conditions. The questionnaire prepared and tried out by the 1953–54 committee was revised in minor respects for clarity and mailed to the entire membership in the United States. A summary of the results from the first 12 questions was published (*EE, Feb '55, pp 96–7*).

Additional analysis of these replies and those on "Associations for Engineers" (questions 13 to 17) will be made and results published.

The tabulated results of the questionnaire were given to the Committee on Employment Conditions, Engineers Joint Council, to be incorporated with those of other societies in a consolidated report on "Professionalism and Collective Bargaining."

4. Voting in District Executive Committee. The question was considered whether only Section representatives should be entitled to vote in the nomination of a Vice-President and selection of a member of the Nominating Committee. The 1953–54 committee recommended (and the Directors approved) that no change be made in Bylaw 33 to limit the voting privileges of any mem-

ber of the District Executive Committee. The committee's recommendation was based on the belief that any District Executive Committee so desiring may, by mutual agreement, adopt special rules to meet the requirements of the District, within the limits of the Bylaws.

5. Financing Special Technical Conferences. In conjunction with the Finance, Technical Operations, and Publication Committees, the committee recommended (and the Directors approved) that the financing of Special Technical Conferences be included in the regular budget for meetings of the Institute. This would include conference expenses, publications, and registration fees.

6. Affiliates as Section Delegates. The committee reaffirmed its recommendation that the Constitution and/or Bylaws be amended to make an Affiliate eligible to represent his Section and vote as a Section delegate at the Conference of Section Delegates and on other Institute or District occasions calling for separate Sections representation.

The Directors declined to approve this recommendation and for purposes of clarification voted changes in the Constitution and Bylaws limiting the voting privileges of Affiliates to Section matters and elections, and restricting eligibility of Affiliates to those offices not requiring participation in District and General meetings as Section delegates or representatives.

7. Ballot for Institute Officers. The committee considered the elimination of the ballot for Institute officers in case of no contest as suggested by some members in returning their ballots. After reviewing the election procedure, the committee concluded that it is as democratic and representative of the membership as any which can be devised, with due regard to efficiency and economy. However, the committee also concluded that the procedure is not universally understood and authorized an article explaining the Institute's system of nomination and election for publication in *Electrical Engineering* and for distribution with the ballots. Accordingly, an article titled "Election Procedure for Institute Officers" was published (*EE, Apr '55, pp. 278–80*) and the accompanying chart was printed on the ballot for 1955–56 officers.

8. Organization and Finance. The Directors authorized the committee to conduct "an over-all study of the present organization of the Institute, including its finances, . . . made with a view to arriving at a more efficient and comprehensive plan of organization designed to operate within the available finances of the Institute and to provide for such subdivisions as may be needed for the efficient administration of the affairs of the Institute in the future. It was further recommended that when this over-all academic plan is completed and approved, it should be provided that it may be put into operation in so far as the change of subdivisions of the Institute is concerned with special reference to District boundaries as it is found feasible and acceptable to the present District organizations."

To assist in conducting this comprehensive study, the committee was authorized to retain the services of Stevenson, Jordan and Harrison Inc., Management Engineers and Consultants. Currently this firm is studying Section meetings and publication costs and revenues to obtain a background of Institute operations.

9. Membership Opinion Research. Originally this assignment was initiated to investigate the feasibility of utilizing selected Section members as personal interviewers to obtain representative views and opinions of the membership as a whole from time to time on various subjects for guidance of the committee in the planning aspects of its work.

However, in studying ways and means to conduct assignment 8 on Organization and Finance, it was recognized early that it would be highly desirable to obtain information of the desires of the general membership immediately. Accordingly, the committee was authorized to employ the services of Opinion Research Corporation, Princeton, N. J., to conduct a personal-interview survey of a scientifically selected sample of the membership to determine their evaluation of the various services rendered by the Institute.

This committee and the Publication Committee are co-operating in the formulation of the questionnaire to be used.

It is contemplated that the results of this survey will be helpful to the management consultants in formulating their recommendations for improvements in AIEE organization, activities, and services to members.

Schedule of Approved Meetings

1955

Pacific General, Butte, Mont., August 15–18

Fall General, Morrison Hotel, Chicago, Ill., October 3–7

1956

Winter General, Hotel Statler, New York, N. Y., January 30–February 3

South West District (7), Dallas, Tex., April 2–4

Great Lakes District (5), Fort Wayne, Ind., April 16–18

North Eastern District (1), Rochester, N. Y., May 2–4

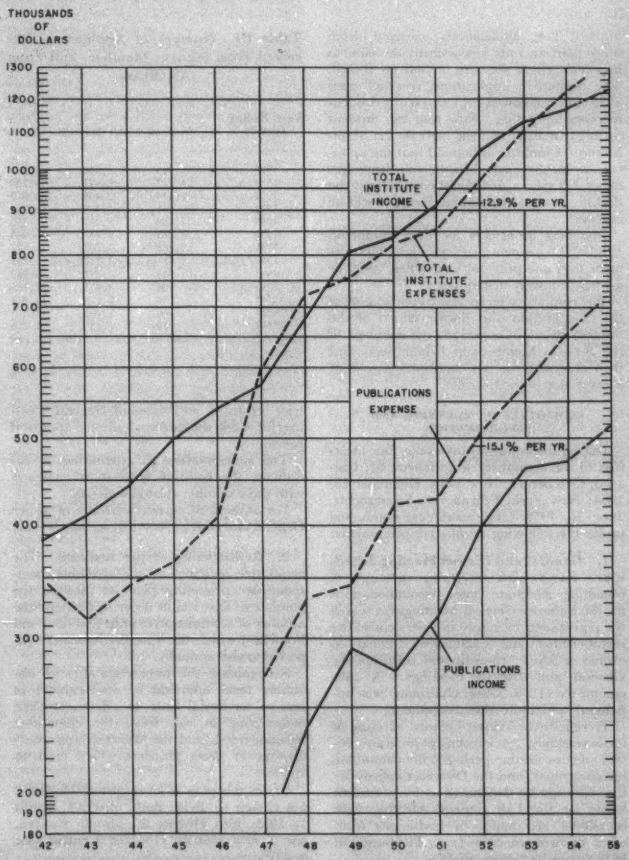


Fig. 1. Institute actual income and expenses in relation to publications income and expenses, years ending September 30.

Summer and Pacific General, San Francisco, Calif., June 25–29
Fall General, Morrison Hotel, Chicago, Ill., October 1–5

1957

Winter General, Hotel Statler, New York, N. Y., January 21–25
Great Lakes District (5), Des Moines, Iowa, April (tentative)
North Eastern District (1), Pittsfield, Mass., May 1–3
Middle Eastern District (2), Dayton, Ohio, May 7–9
Summer General, Montreal, Que., Canada, June 24–28
Pacific General, Yakima, Wash., August 28–30
Fall General, Chicago, Ill., October 7–11

1958

Winter General, New York, N. Y., January 20–24
Summer General, Buffalo, N. Y., June (tentative)
Pacific General, Sacramento, Calif., August 19–22
Fall General, Pittsburgh, Pa., October 27–31

1959

Winter General, New York, N. Y., January 19–24
Summer and Pacific General, Seattle, Wash., June 22–26

1960

Summer General, Atlantic City, N. J., June 19–24

PUBLICATION COMMITTEE

The entire range of publications income and expenses has been studied in relation to Institute income and expenses over a period of years. Early in the study it became apparent that during the last 3 years publications expense had increased at a more rapid rate than total Institute expenses, as shown in Fig. 1, and the rate of increase in income from publications sales had fallen off during the past year. With this background, each of the publications was reviewed, and steps were taken to increase the income and to decrease the costs where possible.

Electrical Engineering. The editorial policy of this publication, which is to carry timely technical articles of broad general interest and 1-page digests of technical papers as well as sections on "Institute Activities" and "Current Interest," has been continued. The last five issues have exceeded a circulation of 60,000 copies which makes control of paper and mailing costs very important. On the basis of laboratory analysis of four different papers, a less expensive paper was selected and this, together with the use of wrappers instead of envelopes, saves $35,000 annually without impairing readability.

Advertising. This activity, which produces the greatest source of publications income, has been understaffed and without sufficient promotional effort in comparison with similar publications. The advertising rates also were considerably below those of comparable publications. The possibility of using the services of other publishers to handle the entire advertising sales on a fee or commission basis was explored. After thorough study with outside firms, and recognition of the fact that outside services would have to carry profit and additional taxes and expenses, it was decided to expand the Institute's own advertising sales and promotional

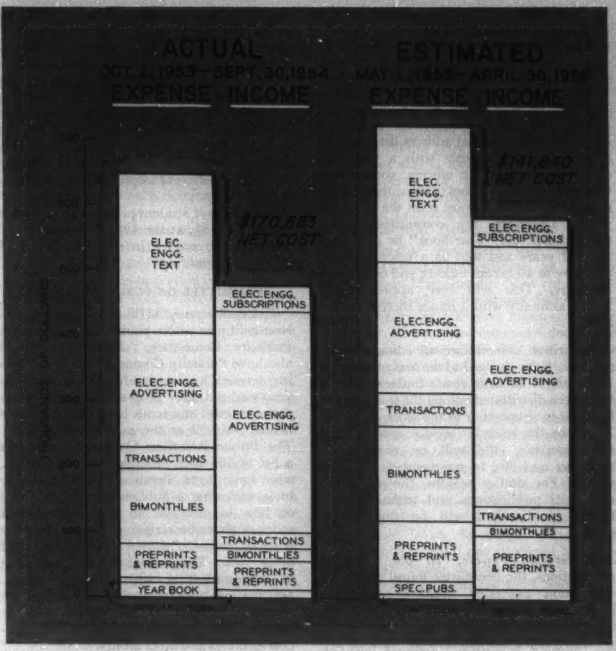


Fig. 2. Actual publications expense and income, 1953–54, compared with estimates for 1955–56.

effort. The Institute was fortunate in obtaining the consulting services of a member who had successfully attacked this problem in one of the other societies.

Beginning on January 1, 1955, the advertising rates were increased 20 per cent. The total number of advertising pages for the first 4 months of 1955 was 300, which is 15 less pages, or 4.76 per cent, than the number during the same period of the previous year. The total number of pages for the year ending April 1955, was 920 compared with 970 for the same period of the previous year, or 5.16 per cent less. This decrease is comparable with the experiences of similar publications and indicates the trend of the times. However, the gross billings for the first 4 months of this year were $13,354 greater than the total billings for the same period of the previous year.

To augment the advertising sales effort, a professional advertising agency has been retained to formulate a sales program and increase promotional activity. Provision also has been made to add an experienced salesman to the staff.

Bimonthly Publications. These publications fill a competitive need through their broad coverage and prompt distribution. The charging of a subscription price for all copies of bimonthlies was considered, but this was believed to be inconsistent with the policy that members should receive all possible technical material that dues will pay for. It was suggested that the bimonthly publications carry advertising, but when it is considered that their circulations are in the order of 10,000 in comparison with 60,000 for *Electrical Engineering*, rates per 1,000 of circulation would have to be very high lest they take advertising away from *Electrical Engineering*. The cost of advertising pages would be $55–$60 per page which, on a combination subscription basis, would put them in severe competition with other publications. The committee recommended that these publications be continued as at present with further thought to be given to the possibility of their development into independent magazines. As these publications carry all of the first costs of composition, engraving, and lock-up and makeready for printing, as well as half of the editorial salaries, to give them up would increase the cost of *Transactions* $89,000 on the basis of next year's budget.

Transactions. *Transactions* serve a useful purpose to members and libraries by preserving a record of the advancement of the art in permanent archives. Volume 73 for 1954, containing 461 papers and 3,040 pages, was made available in April. This was the largest volume in the history of the Institute and contains 73 more papers than the 1953 volume. Part III, "Power Apparatus and Systems," has been divided into two parts, IIIA and IIIB, for more convenient handling.

The committee recommended that the *Transactions* should be continued as at present but that the subscription price to members should reflect actual costs by a charge of $9.00 rather than $6.00 for all four parts; the combination subscription to *Electrical Engineering* and the *Transactions* for nonmem-

bers was increased from $16.00 to $20.00. Ultimately, an estimated increase in revenue of $10,000 from this source is expected.

Year Book. The Year Book was considered to serve a very useful purpose. The inclusion of advertising would increase its bulk and decrease its utility, but it was believed the geographical address list could be published every 2 years with a pamphlet containing lists of the officers, committees, Constitution, and Bylaws to be issued without charge to all who require it on the alternate years. Therefore, the committee recommended that the "Year Book" be published every 2 years and sold at a price of $2.00 per copy to all except officers and committee members. This will save approximately $8,500 annually with a minor increase in income.

Preprints. Heretofore all editorial salaries have been charged to the text of *Electrical Engineering*. In next year's budget, salaries have been distributed among the several publications in proportion to the work involved. To make the preprint service more nearly self-supporting, 40¢ will be charged to members and 80¢ to nonmembers for preprints. For similar reasons, the sale price of special publications and technical conference publications will be slightly increased.

Conference Papers. In the study of publications, the committee found great dissatisfaction expressed because conference papers were not generally available. Conference papers received 60 days in advance are now preprinted and sold the same as are *Transactions*. Authors of conference papers not ready until the time of the meeting were requested to furnish copies which were sold at the 1955 Winter General Meeting for the first time. This practice has successfully been in effect in another society for a period of years.

Summary. The results of these recommended changes can best be summarized by comparing the actual publications expense and income for the year ending September 30, 1954, with the estimated expenses and income for the year beginning May 1, 1955, as shown in the bar charts of Fig. 2. The estimated net cost of publications has been reduced from $170,683 to $141,840, at the same time providing for a 5-per-cent increase in the circulation of *Electrical Engineering*, a 13½-per-cent increase in the editions of the bimonthly publications, and an increase from 418 technical papers a year to 500 technical papers a year plus 220 more conference papers in preprint form. As most changes in publishing operations are fairly long-term propositions, still better results will be obtained in the ensuing year.

COMMITTEE ON PRIZE AWARDS

Expanded channels for recognition of achievement is under study by the Committee on Prize Awards in co-operation with the technical committees. At present, the Institute has direct control of only two medals, the Edison Medal and the Lamme Medal. Favorable consideration is being given to recommending additional medals in such fields as communications, power systems, basic sciences, education, and literature of permanent value. Revisions of rules for Student prizes are also under advisement, including the weighting and interpretation of originality as a factor in judging student papers.

Divergent practices have been noted in awarding of Section and District prizes with a feeling that more uniform objectives may be desirable. One question to be resolved is whether the primary objective of District prizes should be the recognition of outstanding contributions by members of the District or the promotion of improved District meetings.

Division and Student prizes were presented on January 31, at the 1955 Winter General Meeting as recorded in the February 1955 *Electrical Engineering*.

COMMITTEE ON PUBLIC RELATIONS

Practically every AIEE Section is now represented by an active publicity chairman and Publicity Committee. Many Subsections also have Publicity Committees. This growing network has accelerated the public relations and publicity program at the Institute and area level and tends to benefit the membership as well as the profession generally. The Public Relations Committee now has a list of 103 such chairmen, a new record, who have been furnished with publicity tools, including a publicity kit, the manual on how to publicize an AIEE meeting, a series of six radio scripts, copies of the periodically issued *Publicity News Letter*, and other aids. The committee also has been in communication with these chairmen, assisting and advising them when desired on methods of reaching the public and increasing attendance at and interest in Section meetings and other affairs.

It is encouraging to report that the Sections seem to have a growing current interest in keeping the membership and public informed about the profession through the newspapers, radio and television, and the trade press, and in spurring interest in Section activities through their own news letters, direct mail, bulletin boards, and other communications media.

Publicity chairmen and other AIEE leaders charged with promoting District and General meetings are continuing to develop ways and means of attracting the interest and attendance of not only engineers, but also the interest of the general public. This area activity, which has the enthusiastic support of the Public Relations Committee, no doubt was a contributing fact in the record attendance of several meetings during the past year.

The committee through the AIEE public relations counsel, Raymond C. Mayer and Associates, has assisted the publicity chairmen of these meetings by outlining specific publicity procedures; supplying advance articles for newspapers, radio, the trade press, and television stations. News articles have been written from technical papers presented at meetings and made available to newspapers and the trade press and scientific journals. A trained publicity representative from the Mayer association has helped publicity chairmen and their committees during meetings. Such personal aid was furnished to the North Eastern District Meeting at Schenectady, the Summer and Pacific General Meeting at Los Angeles, the Middle Eastern District Meeting at Reading, the Fall General Meeting at Chicago, and the Winter General Meeting at New York. This personalized service was at the request of meeting chairmen and will be continued in the future when requested.

During the year, a revised edition of the publicity kit with ready-to-use materials was prepared and made available to Section and Subsection publicity chairmen and Section chairmen. Four editions of the *Publicity News Letter*, designed especially to aid Section and Subsection publicity chairmen, were prepared and disseminated. The series of six radio scripts, described in last year's report, were completed last summer and were made available to Section and Subsection publicity chairmen. These scripts were written from the layman's viewpoint and were designed to arouse public interest in electrical engineering and to stimulate young people to investigate the profession as a career potential. Two sets of illustrated newspaper mats were sent to 2,500 newspapers throughout the country. These feature mats were designed to show some of the contributions of electrical engineering to the world today. Numerous photographs were taken and made available to the engineering and science journals, house organs, trade press, newspapers, and wire services, both during General and District meetings and at other times.

Institute-wise, the committee, through the AIEE public relations counsel, has publicized such events as election of new officers, and nominees, both on a national and area level; it has publicized a score of technical conferences nationally and through the interested science, engineering, and trade press; on both a national and local level it has publicized naming of new Institute Fellows, awards of the Lamme, Edison, and John Fritz Medals, prize paper winners, Institute changes and appointments, committee chairmen, advance meetings, the Institute's role in a new engineering headquarters, and similar material.

The committee also has co-operated with Institute officers in the preparation of a brochure outlining the advantages of Student membership in the Institute and on a set of slides for Sections.

The committee also has been able to be of assistance on request in publicizing the Eta Kappa Nu Awards, and meetings and appointments of the New York Section.

Close AIEE contact has been maintained with newspapers, radio, and television stations, and with the trade press. The last, in particular, more and more call AIEE public relations representatives as a source of information about the Institute, its meetings, technical papers, etc.

This vigorous and continuing public relations–publicity program which the committee has been engaged in since 1952 has been possible through the sincere support of all segments of the Institute, the Sections, Subsections, and the Headquarters staff.

The committee also held meetings at Los Angeles, Chicago, and New York. The committee chairman served as publicity chairman for the Winter General Meeting Committee.

COMMITTEE ON REGISTRATION OF ENGINEERS

The Committee on Registration has studied the Interim Report of the Committee on Evaluation of Engineering Education of the American Society of Engineering Education. The Committee on Registration

recommended that greater emphasis should be placed on the importance of practical experience of faculty members who teach engineering subjects. Registration as a professional engineer indicates both minimum practical experience and professional standing. It was recognized that educational institutions have such limited budgets that it may be difficult to select all faculty members, who teach engineering subjects, from those qualified for registration. However, it was recommended that the principal members of the faculty be registered as professional engineers. The committee suggested specific changes in wording for the Interim Report in order to emphasize these viewpoints.

COMMITTEE ON RESEARCH

The Committee on Research has continued to promote discussion of the idea that the electrical utility business could profit materially through the initiation and utilization of research, which has for its objective the acquiring of new information which would be directly applicable by the utilities. This program has been under way for 2 years now, and as a result, the committee feels that sufficient interest has been shown in the broad subject to warrant a closer look at the existing situation. For this reason, during the forthcoming year the committee plans to make a study and analysis of the research which is already under way and which is aimed at producing information for the electrical utilities. It feels that before it can make specific recommendations as to what additional research, if any, might be required, the committee should know in some detail just what is currently being done in this field. To that end, a subcommittee of the Committee on Research is being organized which will have the task of organizing and conducting the survey and analysis. As a result of this survey, the committee should be able to report at the next Winter General Meeting what the present status of this type of research is, and to recommend such modifications or additions in this work as seem appropriate.

COMMITTEE ON SAFETY

The year 1954 has seen considerable progress in the promotion of electrical safety among the Institute membership and also in the associated groups concerned with this aspect of safety.

The committee has been successful in scheduling at least one safety session at each General meeting, including a joint session with the Committee on Education. This joint session was devoted to the subject of teaching safety as part of the engineer's technical training.

One of the two projects mentioned in the 1953 Report was completed with the publication of C. L. Smith's report covering "What Causes Electrical Fires," and his discussion of the report at the Winter General Meeting. The second project concerning a comprehensive national report of injuries and fatalities resulting from electrical contact is well on the way to completion and should be of considerable benefit in determining where the committee can best devote its efforts.

The liaison activities have now been expanded to include not only the technical divisions but also the Committee on Standards and the American Society of Safety Engineers.

Two new projects have been added to the committee's agenda. The first is concerned with developing additional recognition of safety as a subject matter for presentation at Section meetings. A "Guide for Safety Activities for Geographical Sections and Subsections" has been developed. It will be presented to the Sections Committee for their approval in the near future, and if approved will be supplied to each Section and Subsection.

The second project is a suggested revision of a 1950 publication, "The Three R's of Electric Utility Safety." The revision will be made with the co-operation of the various technical divisions and, when completed, a draft of the revisions will be made available to the several organizations who may wish to include it as part of their safety publications.

Much of the activity of the Committee on Safety was concerned with encouraging and co-ordinating the safety considerations by other Institute committees in their respective fields. This to be effective required the co-operation of the other technical committees, the officers of the Institute, and many individual members. The Committee on Safety asked that its appreciation for the excellent co-operation received during the current year be expressed to all members as part of this Annual Report.

SECTIONS COMMITTEE

At the Summer General Meeting of the Section delegates at Los Angeles, J. P. Neubauer presented a report on Section Growth Award; prepared by V. L. Ingersoll of the Sections Committee. The first prize of an inscribed gavel was presented to Mr. Carey, chairman of the Michigan Section, which won the award for the larger-than-average Sections. Second place certificate was received by Mr. Greene of the Lehigh Valley Section. The gavel for first place for smaller-than-average Sections was awarded to Mr. Black, chairman of the South Carolina Section. Second prize for smaller-than-average Sections was won by the East Tennessee Section. Mr. Cross received the certificate.

In addition to analysis of Section and Subsection formulation and Section growth, discussion was held on Prize Paper Rules revision, membership problems, student activity, public relations as related to the Sections, formation of ladies' auxiliaries, attendance and fellowship, and grade transfers. A ballot was circulated at noon for selection of items not on the agenda which deserved discussion. Results of this were used in the afternoon and again at the informal winter meeting of Section representatives.

On February 1, 1955, in New York the informal meeting of Section representatives was held for both morning and afternoon sessions. Section meeting attendance was a major item of discussion. No definite conclusions were drawn although it appeared to be concensus that the Institute is serving its members quite well through meetings which they wish to attend. This will be studied further at Swampscott, Mass. The Los Angeles and Chicago Sections reported successful operation of Young Engineers Divisions. These have created great interest among the young engineers in those Sections. The sound and slide program of the Student Activity Committee was explained in detail. Discussion was held on the problem of technical conference financing and a recommendation made to the Board to consider permitting the Section to retain part of the profit if any.

Chairman Scholz of the Membership Committee appealed for efforts to check the declining rate of growth. The Membership Committee should look to other sources besides students for new members. Mr. Yerkes drew attention to a recent pamphlet, "Guide to Transfers of Membership," which is available from Headquarters.

Considerable discussion was held on engineer-in-training certificates as a basis for Associate Membership. The recommendation was made to the Board that they be considered as an alternate requirement for eligibility. It was also recommended to the Board that Fellow certificates and citations should be presented only through the Section to permit real local recognition of the honor.

During the past year, eight new Sections were formed, bringing the present total to 108. Each Section formed was previously a Subsection of the parent Section given in parentheses. The following Sections were approved by the Board in June 1954: St. Maurice Valley (Montreal), Hawaiian (San Francisco), Iowa-Illinois (Iowa), Lima (Dayton), and West Michigan (Michigan). Savannah (Georgia) was approved in October 1954. Baton Rouge (New Orleans) was approved in February 1955, and Johnstown (Pittsburgh) became Section 108 in April 1955. New Sections under consideration are Paducah and Colombia (South America). Calhoun County was transferred from the Michigan Section to the West Michigan Section.

There now is a total of 63 Subsections. Six new Subsections were formed this year as follows: Aiken-Augusta (South Carolina), Los Alamos–Santa Fe (Northern New Mexico), Medford (Portland), Northwest Iowa (Iowa), Quebec (Montreal), and Riverside–San Bernardino (Los Angeles). Additional Subsections under consideration are Caracas, Cocoa Beach, Puerto Rico.

The Institute appears to be having a healthy growth in number of operating units which, however, may well lead to a requirement for further new Districts to accomplish suitable administration.

STANDARDS COMMITTEE

The rapid expansion of technical activity within the Institute and the increasing number of technical committees has resulted in greater interest in standardization activities in AIEE and in the American Standards Association and other standardizing bodies with which the AIEE is associated. The Standards Committee has received from many sources within the Institute questions as to whether AIEE is continuing to hold its rightful position in the development of electrical standards. The Standards Committee feels that AIEE is not losing ground but agrees with the technical committees that there is much that can be done to maintain a closer liaison between the technical committees and the members who are acting as AIEE representatives to various standardizing bodies. Subcommittees are now working out the details of a plan, proposed by the Standards Committee and the technical

committees, which should greatly strengthen the position of AIEE.

The following standards work has been approved:

Revision of Recommended Practice for Electrical Installations on Shipboard, No. *45*, to supersede the 1951 edition.

Revision of Test Code for Aircraft Circuit Interrupting Devices, No. *801*, to supersede the 1950 report.

Guide for Specification of Electronic Voltmeters, No. *450*.

Guide for Specification of Signal Sources, No. *451*.

Guide for Specification of Cathode-Ray Instruments, No. *452*.

Test Code for Power Factor Testing of Power Transformers, No. *505*.

Master Test Code for Electrical Measurements in Power Circuits, No. *552*.

Test Code for D-C Carbon-Pile Voltage Regulators for Aircraft, No. *802*.

Application Guides for:

—Ground Fault Neutralizers

—Grounding of Synchronous Generator Systems

—Neutral Grounding of Transmission Systems

No. *954* (issued as a committee report)

The Standards Committee reviewed and accepted as American Standards, under ASA procedure:

Switchgear Assemblies and Metal-Enclosed Bus, *C37.20* (AIEE No. *27*), to supersede the 1952 edition of AIEE No. *27*.

Test Code for Polyphase Induction Motors and Generators, *C50.20* (AIEE No. *500*), to supersede the 1937 edition of AIEE No. *500*.

Proposed Revision of Electric Railway Control Apparatus, *C48* (AIEE No. *16*) 1931.

Proposed Revision of Table *11.030* of *C57*.

Proposed Revision of Sections *12.050*, *12.051*, and *22.105* of *C57*

COMMITTEE ON STUDENT BRANCHES

During the past year the Committee on Student Branches continued the preceding year's program of sending the Branches various kinds of information, such as:

1. Posters directing attention to articles in *Electrical Engineering* of interest to students.
2. Periodic letters of information about new policies and practices relating to Student membership and Student Branches.
3. Distribution to the Branches of supplies of "Student Information" folders and the "Registration as an Engineer" folder.

New policies and procedures, which were placed in effect during the past year, were as follows:

Headquarters was authorized to send one complimentary copy of *Electrical Engineering* and one complimentary copy of each of the three bimonthly *Transactions* publications to the counselor of each Student Branch, to be made available for the students of electrical engineering in his school as he deems to be most effective in acquainting the students with these publications. A price of $1.00 per year for Student member subscriptions to the bimonthly publications to the extent of one such publication to each student was also authorized.

Additional travel allowance was provided for Branch counselors, which would enable them to receive mileage allowance to one District Committee Meeting on Student Activities a year, as well as mileage allowance to the annual District Prize Paper Contest, if and when their Branch is competing.

Two sound-slide films were made and copies were distributed for use at Branch meetings. The first one, prepared in cooperation with the Westinghouse Electric Corporation, was titled "Expanding Opportunities for Tomorrow's Electrical Engineers." "Success Story" is the title of the second film sponsored by the Allis-Chalmers Manufacturing Company as a sequel to the first film. The subcommittee in charge of this project is at work on plans for making additional sound-slide films during the coming year.

The first edition of the "Student Branch Manual" was printed and issued. The subcommittee on this project is now engaged in the preparation of a second edition which will be printed in August and distributed to the Branches not later than September 15, 1955.

The report and recommendations of the Subcommittee on Student Affiliate Membership and Affiliate Branches was received and approved by the Committee on Student Branches and the Directors. The report and other details was published in the June issue of *Electrical Engineering* (*p. 533*). Complete details will also be published in the August 1955 issue of the "Student Branch Manual." It provides for a new Student Affiliate grade of student membership which is available to students in a 4-year engineering curriculum not accredited by Engineers' Council for Professional Development (ECPD). Dues for Student Affiliates, the publications they receive, and other privileges are the same as regular Student members, except that upon completion of his academic work, the Student Affiliate may be admitted only to the Affiliate grade. After a Student Affiliate has been admitted to the Affiliate grade of membership, his advancement to the Associate Member grade will be subject to the same requirements as any other Affiliate member. The plan also makes provision for the establishment and operation of Affiliate Branches in such 4-year nonaccredited colleges, upon approval of the Board of Directors. The necessary Bylaws changes and additions to put the plan into effect were approved by the Directors at their April 14, 1955, meeting.

Table VI. Section, Subsection, and Technical Group Statistics

	For Fiscal Year Ending April 30							
	1939	1940	1941	1942	1943	1944	1945	1946
Organizational Units								
Sections	68	70	72	72	73	73	73	75
Subsections		1	1	1	3	6	13	27
Technical groups	24	26	23	14	17	31	54	86
Meetings								
Section	541	583	587	591	536	586	617	675
Subsection		3	6	8	10	37	89	150
Technical group	98	117	104	49	52	115	176	359
Joint								
Total meetings	639	703	697	648	598	738	882	1,184
Attendance								
Section meetings	73,781	76,955	76,636	72,569	60,932	55,307	64,621	77,521
Subsection meetings		125	200	585	617	1,853	5,074	8,418
Technical group meetings	12,197	14,970	13,529	5,285	4,544	25,079	26,683	30,706
Joint meetings								
Total attendance	85,978	92,050	90,365	78,439	66,093	82,239	96,378	116,645

	For Fiscal Year Ending April 30								
	1947	1948	1949	1950	1951	1952	1953	1954	1955
Organizational Units									
Sections	71	81	85	87	89	94	97	100	107
Subsections	35	41	49	51	54	54	51	57	64
Technical groups	119	111	114	103	100	102	123	115	125
Meetings									
Section	723	757	845	886	924	966	960	1,028	1,079
Subsection	190	251	329	359	376	331	344	407	421
Technical Group	460	455	440	438	427	443	463	488	540
Joint					3	22	26	27	16
Total meetings	1,373	1,463	1,614	1,683	1,730	1,762	1,793	1,950	2,056
Attendance									
Section meetings	115,171	77,386	85,955	88,799	87,380	85,125	92,464	92,522	91,341
Subsection meetings	12,111	14,437	18,807	20,252	16,680	13,735	13,825	16,703	15,692
Technical group meetings	27,891	30,782	27,471	32,919	22,028	27,195	27,093	24,539	25,764
Joint meetings					406	2,746	2,199	2,027	1,283
Total attendance	155,173	122,605	132,233	141,970	126,494	128,801	135,581	135,791	134,080

Table VII. Branch Statistics

	For Fiscal Year Ending April 30					
	1950	1951	1952	1953	1954	1955
Number of Branches	130	133	132	135	135	135
Number of meetings held	1,318	1,303	1,178	1,250	1,116	1,158
Total attendance	81,815	63,369	49,324	45,895	49,213	53,325

The Directors, at their February 3 and April 14 meetings, made effective a procedure whereby Student member applicants for admission to the Associate Member grade may be accepted promptly after graduation, thereby enabling them to enjoy Associate Member grade at a reduced annual dues rate of $5.00 until the beginning of the next fiscal year.

At the April 14 Directors meeting, Bylaws changes were also approved to permit graduate students whose bachelor's degrees were obtained in ECPD-accredited schools to be admitted to the Associate Member grade without payment of the entrance fee, and to permit graduate students to carry their Associate Member grade at a reduced dues rate of $5.00 per year, provided they are devoting not less than one half of full time to studies in an ECPD-accredited institution.

The AIEE–Institute of Radio Engineers Ad-Hoc Committee on Joint Student Branches completed its work and its report has been approved by both societies. The report covers finances and operation, Joint Student Branch Regulations, and a procedure for future co-ordination. The report will be published in the August 1955 issue of the "Student Branch Manual."

A Student Branch for Youngstown College, Youngstown, Ohio, has been approved. Affiliate Branches have been approved for Lamar State College, Beaumont, Tex.; Texas College of Arts and Industries, Kingsville, Tex.; Tennessee Polytechnic Institute, Cookeville, Tenn.; and the University of Houston, Houston, Tex.

The up-trend in Student membership continued during the year. On May 1, 1955, there were 7,666 Student members, compared to 6,904 on May 1, 1954.

The Committee on Student Branches held two meetings during the year, one in Los Angeles, June 21, 1954; the other in New York City, February 1, 1955.

COMMITTEE ON TECHNICAL OPERATIONS

During the past year, the Committee on Technical Operations has continued its assignment of supervising the technical affairs of the Institute. Much of the activity of the technical committees is co-ordinated by the several division committees, but when these activities cross division lines, the Committee on Technical Operations acts as the co-ordinating agency.

The following items have been considered by this committee during the past year.

Paper Regulations. The 1955 Winter General Meeting was the first meeting at which the paper regulations, described in the "1954 Report of the Board of Directors," were in effect. These regulations concerned the preprinting and sale of conference papers received at Institute Headquarters at least 60 days prior to the meeting. From a total of 190 conference papers, 42 were preprinted and made available for sale. A number of other conference papers, which failed to meet the 60-day requirement, were turned over to the sales desk by their authors for sale and distribution.

All conference papers are identified by serial numbers, but only those preprinted by the Institute are identified by number in the advance and final programs.

After a preprinted conference paper is presented, written discussion of the paper is accepted and retained at Institute Headquarters pending further action on the paper. If the author or the concerned committee requests it, the paper is reviewed in the same manner used for reviewing proposed *Transactions* papers. If the paper is rejected in the process of reviewing, no further action is necessary and the discussion is destroyed. If the paper is accepted without revision, it is then classified as a *Transactions* paper and is announced to the membership by a notice in one of the bimonthly publications. Further discussion is accepted within certain time limits (about 30 days after the latter announcement) and all discussion is then published with the paper in the appropriate bimonthly publication.

All conference papers that are not preprinted by the Institute, will continue to follow the present procedure of review and, if accepted, placed on the program of a suitable session for "re-presentation for discussion."

After considerable discussion and consideration of proposed names for conference papers, the committee has agreed to retain the title of "conference paper."

Author's Guide and Technical Sessions Guide. The Author's Guide prepared in 1953 has been in use for a little over one year. Revisions are now being considered in the attempt to make the information more effective.

A number of comments have been received concerning the "Technical Sessions Guide" which has also been in use for approximately one year. These are being studied and a new guide will be made available in the near future. The ultimate plan is to provide a loose-leaf "Handbook of Technical Committee Operations," which will provide information for technical activities in all areas of Institute operation

Forum of Technical Committee Chairmen. The Committee on Technical Operations is responsible for the scheduling and conducting of a forum of technical committee chairmen, which is required to be held at least once each year. Two forums have been held during the past year, one at the Fall General Meeting and the other at the Winter General Meeting. Because of the interest shown by the technical committee chairmen and other officers of the Institute, it was agreed that forums should be held in connection with the three General meetings of the Institute. Such meetings serve as opportunities for the indoctrination of new technical committee chairmen and provide places for discussions of Institute policies. Being held shortly after meetings of the Committee on Technical Operations, it makes it possible for technical committee chairmen to receive quickly information concerning the actions taken at the Committee on Technical Operations meetings. Subjects for discussion have been items such as the scheduling of General meetings, how the publication policy of the Institute operates, and standards activities of technical committees.

Division Committees. As the co-ordinating agency for the technical activities for the five division committees, the Committee on Technical Operations has been concerned with several items during the past year. Among these are the following:

Organization for Topics of Concern to Several Divisions. A small subcommittee has studied this problem and prepared an interim report which is under discussion by the several divisions. Some kind of procedure is definitely needed to cover treatment of important and basic subjects of broad interest, to insure that the results represent, as far as practicable, the over-all AIEE information and viewpoint.

Multiple Review of Transactions Papers. Because it is difficult, in some instances, to establish a single committee as the reviewing body for some *Transactions* papers, a subcommittee is engaged in developing a plan for handling reviews of these papers. There are some cases in which a committee will sponsor a paper which is outside its scope, and, in order to avoid misunderstandings, a plan is necessary for the handling of these.

Community of Interest. The interests of many Institute members encompass several related fields, which, to insure proper coverage of the subject matter, are assigned to separate technical committees. For example, the theoretical aspects of insulation are the concern of the Committee on Basic Sciences; the applications of insulation are found in the scopes of the Committees on Insulated Conductors, Rotating Machinery, and Transformers, as well as being of interest to others. When sessions are set up by the several technical committees, it is difficult to avoid every possibility of sessions in related fields from occurring at the same time.

A subcommittee has been assigned to study the problems of conflicting technical sessions and conversely, those of widely separated sessions at Winter General Meetings, and to propose some procedure for improvements in scheduling.

Proper Allocation of Technical Papers for Divisional Publications. A subcommittee has been appointed to consider the subject matter of *Transactions* papers and to establish a plan for selecting the most appropriate bimonthly publication in which to publish certain papers. For example, a paper on an electronic subject may be of more interest to readers concerned with the applications of the device rather than in the device itself.

Proposed Technical Committee and Scopes. The Committee on Technical Operations has under consideration the formation of three new technical committees: Committee on Communication Theory (Communication Division), Committee on Dielectrics (elevation of the Subcommittee on Dielectrics of the Committee on Basic Sciences), and the Committee on Solid State Devices (Science and Electronics Division). The scopes for these committees, along with the title and scope of the Committee on Industrial Power Rectifiers (formerly Committee on Electronic Power Converters), are all being considered by the divisions for action at the next meeting of the Committee on Technical Operations.

Improving Division Service to Institute Membership. A special subcommittee is considering methods by which a better "feeling of belonging" to certain technical areas of activity can be developed. This will involve such matters as a selective mailing list for Special Technical Conferences, cataloging of members by interest (similar to that done in The American Society of Mechanical Engineers), and establishing a closer con-

tact between members and technical committees in which they have a primary interest.

COMMITTEE ON TRANSFERS

During the past year, the Committee on Transfers has been active in disseminating as widely as possible throughout the membership acquaintance with the new requirements for the various grades of membership in the Institute which became effective in 1951. All Sections have been encouraged to form Transfers Committees and the "Guide to Transfers of Membership," which was published in March 1954, has been placed in the hands of the officers of all Sections. To this end, certain Sections have been allocated to each member of the Committee on Transfers to further the committee's objectives, all Sections and Subsections thus being brought within the committee's purview. In this activity, particular emphasis is being laid on the matter of transferring from one grade of membership to another, with special attention being directed to transfers from Member to Fellow grade.

Along this line, the subject was presented to the Section delegates at their conference during the Summer General Meeting at Los Angeles in June 1954, and again to the Sections Committee during the Winter General Meeting in New York in February 1955.

The number of transfers between grades are shown in Table I on a previous page.

The committee held one meeting during the year at the Winter General Meeting in New York in February 1955. The members present displayed great enthusiasm in the committee's work, and they, as well as the other members who were unavoidably absent from the meeting, have continued to show their interest in transfers work by carrying the committee's objectives back to the Section in their respective parts of the continent.

TECHNICAL DIVISIONS AND COMMITTEES

Communication Division

COMMITTEE ON COMMUNICATION SWITCHING SYSTEMS

The programs sponsored last year met, in general, the objectives of the committee. Technical sessions were sponsored at the Summer and Pacific, Fall, and Winter General Meetings. Committee meetings were held coincident with these meetings.

One of the aims of the committee is to develop programs having a common theme and having particular appeal to one of the several areas of interest in the field of communication switching. While emphasis is placed upon the system, there is also a great deal of interest in new developments in components and in new concepts of theory.

Nation-wide dialing continues to be a very fascinating subject and one or more papers dealing with various aspects of it were presented at each session. They included a report on the operating experience with some of the new equipments, a view of the situation by an independent telephone manufacturer, and a demonstration of common control telephone switching principles.

The Fall General Meeting, at Chicago, Ill., in 1954, is scheduled to be held in Chicago for the next several years. The committee feels that this meeting is especially appropriate for the programs of particular interest to the engineers of the independent telephone companies. Therefore, the technical sessions for the Fall Meetings are planned to report on developments of the field of telephone switching. Appropriate papers by independent manufacturers and operating companies are encouraged.

A highly successful technical session devoted to demonstrations of various aspects of switching was held 2 years ago. Since then additional new equipment has been developed to illustrate theoretical and logical considerations of serious import to the application of large-scale switching systems. Papers covering three new demonstration sets were sponsored at the Winter Meeting. In view of the response, it is expected that a similar session will be considered at 2-year intervals.

The committee has made plans to sponsor a session at the Summer General Meeting. Rather than restricting it to a single theme, it will be a general-interest meeting with papers on subjects ranging from theory to practice.

The committee membership has increased in numbers and in the proportion of those taking an active interest in the program. As a result, the technical sessions should provide a more comprehensive coverage of the communication switching field.

COMMITTEE ON RADIO COMMUNICATIONS SYSTEMS

Special efforts are being made to secure papers in specific fields of technical developments, such as uhf radio propagation. While much work is being done in this propagation field, there will be some delay before certain of this material becomes available for publication. The committee also feels that much important technical work is being done in the foreign field and would welcome papers by membership overseas.

The need for papers describing entire operating systems in broad technical fashion has attention. In this connection it is realized that Student members and younger engineers with their extensive concentration on more limited aspects of the technical field might be prone to overlook the advantages of a broader coverage. Perhaps if the managerial aspects of designing and operating complicated technical systems could be stressed in accordance with present-day emphasis on management's rule, the younger engineers' interest might be stimulated more extensively.

The growth of automation in industry generally and particularly in the service fields, such as transportation, electric power, and pipe lines, will require the development and use of increasingly complex radio communications systems. In addition, the enormous scope of global defense demands extensive and enlarged communications systems and technical advances. It is the committee's intention to secure its membership from as many of these fields as possible to insure proper coverage.

Finally, it is hoped to interest prospective authors in a further improvement in the caliber of the papers prepared for presentation at the General meetings and for publication.

COMMITTEE ON SPECIAL COMMUNICATIONS APPLICATIONS

During the past year this committee sponsored two technical sessions, one at the Summer and Pacific General Meeting and the other during the Winter General Meeting. In keeping with the broad field embraced in the scope of this committee, each session covered a variety of subjects, both technical and nontechnical. Included were such items as recent developments in magnetic-tape data-recording systems, automatic telegraph concentrators, the use of a tapered strip transmission line for pulse transformer service, and economic factors affecting the design of magnetic pulsers. In addition, there were two interesting contributions of a more nontechnical nature covering some little-known aspects of the early history of electricity, and a recounting of some of the civilian defense preparations made by foreign administrations during World War II, together with a summary of their effectiveness.

A committee meeting was held during the Winter General Meeting at which a number of promising subjects were suggested as a basis for the committee's work during the coming year.

COMMITTEE ON TELEGRAPH SYSTEMS

During the first part of the year the main activities of the committee were in securing technical papers for presentation at the Winter General Meeting where eight such papers were presented in two sessions sponsored by this committee. Other activities during this period included the designation of one of the committee members to serve as a representative for liaison with the Standards Committee.

A committee meeting was held during the Winter General Meeting at which plans were made for the coming year's activities through the Fall General Meeting. As a result the committee is sponsoring one session at the Summer General Meeting and one session at the Fall General Meeting with suitable papers planned and underway for each of these meetings. Consideration was also given to the desirability and feasibility of committee work toward the standardization of methods, means, and terminology for testing printing telegraph transmitting and receiving machines, particularly those of the start-stop variety, to determine their characteristics as regards distortion of sent signals and tolerance to distortion of received signals. It was concluded desirable to form a subcommittee to consider this subject and this is being done.

The committee received an article proposed for publication in *Electrical Engineering* on the subject of research and development in teletypewriter and teletypewriter switching equipment in the Signal Corps. This article was not submitted as a *Transactions* or conference paper but was reviewed by the committee and recommendations made regarding it to the editor of *Electrical Engineering*.

COMMITTEE ON TELEVISION AND AURAL BROADCASTING SYSTEMS

Significant progress was made throughout the year in color television. Over-all system performance has been improved by new developments in pickup cameras and associated equipment, intercity microwave

circuits, transmitters, receivers with large-screen tricolor kinescopes, and improved test procedures. This growth in color television has been reflected by the committee through meeting sessions designed to bring these developments to the attention of the members.

Satellite television transmitters, designed to retransmit and boost weak television signals, have received widespread Federal Communications Commission and industry attention. Authorities in the field have described these developments to AIEE members. Other advances covered by the committee included: broadcast antennas, high-powered broadcast transmitters, propagation, magnetic recording, and high-fidelity amplifiers.

The committee sponsored technical sessions at each of the three General meetings and furnished papers for two District meetings. Committee meetings were held at each General meeting with good attendance. Sessions have been planned for the 1955 Summer General, Pacific General, and Fall General Meetings. Two sessions planned for the 1955 Fall General Meeting will include a review of the rapid growth of closed-circuit television. Such topics as theater television, subscription television, community cable and antenna installation, and hospital television will be covered at this meeting.

COMMITTEE ON WIRE COMMUNICATIONS SYSTEMS

Technical sessions were sponsored by the committee at the Pacific, Fall, and Winter General Meetings. The sessions at the Pacific Meeting emphasized the subject of *E*-type repeaters used for negative impedance loading of telephone circuits. This subject was considered timely because it coincided with the large-scale application of the newer type repeaters in the Pacific area.

One of the sessions at the Fall Meeting was sponsored jointly with the Committee on Radio Communications Systems, and included papers on military communication systems, both carrier and radio. The other session was devoted to papers on international communications, including a paper on the new transatlantic telephone cable by British and American authors. The Winter Meeting highlighted the problems of serving rural telephone subscribers by carrier. Two papers on the use of aluminum in the communications field were sponsored at the Conference on the Electrical Utilization of Aluminum at Pittsburgh, Pa., March 15–17, 1955. Arrangements have been completed for one session at the Summer Meeting covering a variety of subjects. Committee meetings were held during each of the General meetings and another is scheduled for the next Summer Meeting.

Continued interest was shown in the problem of furnishing low-cost telephone service to rural subscribers and additional papers on this subject are under active consideration. The outstanding development in the field of long-distance communication announced during the year was the transatlantic telephone cable. The committee plans to follow closely the activities incident to the laying of the cable and placing it in service and expects to sponsor timely papers on the various problems encountered in this installation.

General Applications Division

COMMITTEE ON AIR TRANSPORTATION

The committee sponsored two sessions at the 1954 Summer and Pacific General Meeting, Los Angeles, Calif., and eight sessions at the Fall General Meeting, Chicago, Ill.

Recognition of the existing AIEE Standard Test Codes by the Aircraft Industries Association (AIA) has been obtained. The AIA will distribute a published list of the AIEE Standards with their official endorsement throughout the aircraft industry. A procedure for adding new AIEE Standards to the list as they become available has also been established.

Additional technical activities were carried on by five active subcommittees.

Subcommittee on Electrical Control, Protective Devices, and Cable finalized the "Test Code on Aircraft Circuit Interrupting Devices," which is now being published under AIEE Test Code No. *801*. The proposed "Test Code on Carbon Pile Voltage Regulators for Aircraft" was submitted and approved by the Standards Committee for publication on a 1-year trial basis. The remainder of activity was confined to giving assistance to the Aircraft Electrical Systems Subcommittee in writing Section *400* of the "Systems Manual."

Subcommittee on Dielectric Testing Procedures for Aircraft Electrical Equipment and Insulation Materials has completed a rigorous investigation program and developed a preliminary "Aircraft Electrical Insulation Test Code" which was submitted to the Committee on Air Transportation on October 15, 1954. After incorporation of the suggested changes and conducting of the suggested additional investigations it is hoped that a proposed test code will be ready to submit to the Standards Committee for publication on a 1-year trial basis by the fall of 1955.

Subcommittee on Rating of Airborne Electric Apparatus has confined its efforts to the thermal rating of rotating equipment and has divided the committee into three groups. The applications group has prepared an "Airplane Thermal Data Chart for Installation of Self-Cooled Electrical Equipment." The self-cooled equipment group has prepared a document entitled: "Procedure for Testing Aircraft Totally Enclosed Fan-Cooled Induction Motors" and is working on similar documents for other types of motors. The blast-cooling group has written a proposal entitled: "A Proposed Interim Method of Presenting Blast-Cooled Generator Rating Data."

Subcommittee on Aircraft Electrical Systems has, for its present assignment, the revision of publication AIEE No. *750*, "Aircraft Electric Systems Guide." The revision is complete on nine sections and a first draft complete on five other sections. Additional sections are in work.

Subcommittee on Aircraft Electrical Rotating Machinery is revising the "Test Code on Aircraft A-C Motors" and preparing a "Test Code for Aircraft A-C Generators." An AIEE Guide Report on the "Standardization on the Presentation of Aircraft Generator Characteristics" is in preparation.

At the annual business meeting of the committee in Chicago, October 15, 1954, it was decided to hold a Special Technical Conference on Aircraft Electrical Applications in Los Angeles, Calif., October 11–13, 1955.

COMMITTEE ON DOMESTIC AND COMMERCIAL APPLICATIONS

As in the past several years only one committee meeting was held during the year (at the Winter General Meeting) as the principal work of the committee is carried on by the subcommittees. A brief discussion of the year's activities was held including the question of taking up more of the subjects mentioned in the committee's scope than are now covered by the subcommittees. It was felt that the rather wide diversity now existing between subcommittees' fields of activity did not justify further expansion as it would tend to break the committee into too many small groups. At some future time it is possible that one more of the subcommittees might become a full committee as the subject matter and audience participation grows.

Liaison is maintained with the AIEE Standards Committee, two ASA committees, and the National Farm Electrification Conference. Currently the committee is reviewing several proposed standards submitted to it for comment.

Subcommittee on Electric Space Heating and Heat Pumps (East) has continued the very successful series of technical sessions sponsored at the Winter General Meeting for the past several years. Over 200 people attended the session. Several papers of *Transactions* quality were presented along with the other good conference papers, indicating that the efforts of the subcommittee chairman to develop technical papers was bearing fruit. This trend should continue although this subcommittee will begin to broaden its scope of subject matter in order to keep its "best foot forward" at the Winter General Meeting.

Subcommittee on Electric Space Heating and Heat Pumps (West) sponsored two technical sessions at the Summer and Pacific General Meeting last June and is planning to sponsor at least one session at the Pacific General Meeting at Butte, Mont., this August. The distances involved have made it difficult to build up the activities of this subcommittee, but it is hoped to continue its contributions on a yearly basis until better established, and then maybe consider a Special Technical Conference. Such a conference appears unlikely in the near future, however.

Subcommittee on Domestic Appliances conducted its Sixth Appliance Technical Conference in Cleveland, Ohio, in May. This series of conferences held with the aid of various local AIEE Sections continues to be very successful and offers a forum for discussion of many highly interesting and important problems concerning appliances which are not necessarily exclusively electric in nature.

Subcommittee on Farm Electrification was able to hold a 3-day Special Technical Conference in Chicago in March after several years of trying to get started on this project. The conference was highly successful in highlighting the tremendous progress made

in putting electricity to work on the farm. It is contemplated that such a conference might be held every other year with encouragement of written papers presented at regular technical sessions in between.

COMMITTEE ON MARINE TRANSPORTATION

The committee has continued its practice of meeting twice yearly to consider desirable modifications and additions to AIEE Standard no. *45*, "Recommended Practice for Electric Installations on Shipboard." Meetings were held on May 14 and October 5, 1954, and another meeting scheduled for May 27, 1955.

In March 1955, a new edition of Standard *45* was issued. Because of the increased use of electronic apparatus on shipboard, a complete new section is included on electronic communication and navigation equipment, which replaces the three previous sections covering applications for radio communication, radio compass (direction finder), and echo sounding. A new section on electrically operated galley equipment, and new material on a-c switchboards, are also included in the 1955 revision of Standard *45*.

The committee served as an advisory group on marine electrical practice to the U. S. National Committee at the Golden Jubilee meeting of the International Electrotechnical Commission (IEC) in Philadelphia, Pa., on September 7–16, 1954. The U. S. chief delegate on marine matters at this meeting is also the chairman of AIEE's Marine Subcommittee on International Standardization. During the course of the meeting, IEC Technical Committee *18* approved the greater part of a code of recommendations for marine electrical practice which is intended to be the basis of standardization of marine practice throughout the world.

As a further step towards international standardization of marine electrical practice, the October 5 meeting of the Committee on Marine Transportation was devoted to discussion with the chief engineer of Lloyd's Register of Shipping (who is a member of the Committee on Marine Transportation and was the chairman of Technical Committee *18* at the IEC meetings in Philadelphia) concerning differences between the recommendations contained in Standard *45* and Lloyd's rules.

In view of the many questions which came up during the Philadelphia meetings, several members of the committee are planning to attend the next meeting of Technical Committee *18* which will be held at The Hague, Netherlands, late in 1955.

The Committee on Marine Transportation is formulating plans for another marine session at the 1956 Winter General Meeting in New York. The interest and response to the 1954 Marine Session has encouraged the planning of such sessions to be held biannually at the AIEE Winter General Meetings.

COMMITTEE ON PRODUCTION AND APPLICATION OF LIGHT

A Fall General Meeting session was jointly sponsored by the Industrial Power Systems, the Transmission and Distribution, and the Production and Application of Light Committees. The contribution from this committee was an analysis of the advantages of operating fluorescent lighting on 360-cycle 600-volt systems and a description of the first large-scale installation of such a system in the Union College Field House. The presentations proved to be of wide interest to the session audience and to other members of the Institute. By invitation, the committee also sponsored a paper at the Aluminum Conference in Pittsburgh. It described the electrical and mechanical characteristics of aluminum when used in lamp bases from both the lamp manufacturing and lamp users' viewpoints.

Last year's Board Report reviewed the study this committee has been making of its relation to other technical committees and its most effective mode of operation. Further analysis and the successful Fall General Meeting and Aluminum Conference experiences have strengthened the opinion that closer liaison with several other committees should be developed. Also, joint rather than sole sponsorship of sessions will be advantageous in most instances.

Industry Division

COMMITTEE ON CHEMICAL, ELECTROCHEMICAL AND ELECTROTHERMAL APPLICATIONS

This committee has been very active during the past fiscal year. A technical session was sponsored by the Cathodic Protection Subcommittee at the 1954 Fall General Meeting; the Electrochemical, Cathodic Protection, and Chemical Industry Subcommittees each sponsored sessions at the 1955 Winter General Meeting; the main committee sponsored a session at the 1954 Summer General Meeting.

This year has seen the formation of the Pacific Coast Subcommittee. This subcommittee will cover the entire scope of the main committee, but their primary interest will be in the Pacific Coast states. It is expected that the various subcommittees will trade quite a few papers with this Pacific Coast group so that we should get good nation-wide coverage for the committee.

The Electrothermal Processes Subcommittee has begun work this year in co-operation with the Transformer Committee on the preparation of standards for furnace transformers. This work will be carried on primarily by the Transformer Committee, but the Electrothermal Processes Subcommittee has appointed a working group to work with them on the preparation of these standards.

This committee has been co-operating with the Safety Committee by sponsoring several papers in the technical sessions held at the General meetings on the subject of safety. It is expected that this activity will increase during the forthcoming Institute year.

This committee has expanded its membership during the past year so that now the membership of both the committee and subcommittees represent a well-rounded group consisting of users, consulting engineers, and manufacturers. Since most of the membership is quite active (as indicated by nearly 100-per-cent attendance at the committee meeting in February 1955), it is expected that this balanced group will continue to be active and progressive.

COMMITTEE ON ELECTRIC HEATING

The second Institute conference covering various phases of industrial heating was held May 10 and 11, 1955, at the LaSalle Hotel, Chicago, Ill., under joint sponsorship of the Committee on Electric Heating and the Chicago Section. Sixteen technical papers were presented covering many phases of and many new developments in the field of electric industrial heating.

The Subcommmittee on Induction and Dielectric Heating has been very active in assisting with the program and organization for the conference as well as in these other ways. The tentative AIEE Standard *54* covering induction and dielectric heating was thoroughly revised, approved by the parent committee, and is now in the hands of the Standards Committee for final approval. The subcommittee decided to aid the cause of induction and dielectric heating by preparing and maintaining a bibliography. A task force has been formed to carry out this assignment. One of the subcommittee's prime functions, that of studying the radio-interference cases cited by the Federal Communications Commission (FCC), disclosed a need for more detailed study of the subject. As a result the December 1954 meeting was given over to a complete discussion of FCC Rules and Regulations—Part 18. Representatives from FCC and the Civil Aeronautics Administration in the New York City area were present. Based on the findings at this meeting a task force has been formed to study the problem of power-line interference and radiation. Other task forces will be formed to study such problems as "high-angle" radiation from industrial installations and better definition of measurement techniques and field-strength-measuring instruments.

The Radiant Heating Subcommittee is following with great interest the development of the new quartz lamps and their possible applications. Work is being done toward development of some standard method of temperature measurement that could be adopted by the industry.

COMMITTEE ON ELECTRIC WELDING

Plans are being made for the fifth Conference on Electric Welding to be held jointly with the American Welding Society (AWS).

The committee had two business meetings, one in Chicago in November during the National Metal Exposition and the AWS Fall Meeting, and the other at the AIEE Winter General Meeting.

Subcommittee on Fundamental Arc Research sold more than 400 copies of the "Bibliography on High-Pressure Electric Arcs" this year. A meeting of this subcommittee was held in February at the AIEE Winter General Meeting.

Subcommittee on Instrumentation for Resistance Welding remained very active in gathering information to prepare a report for the AIEE Instruments and Measurements Committee on measurements of quantities encountered in resistance welding. The object is to obtain the assistance and benefits of the know-how of the Instrumentation and Measurements Committee and the AWS to prepare a handbook on instrumentation practices. This subcommittee held four meetings during the year.

COMMITTEE ON GENERAL INDUSTRY APPLICATIONS

The committee has been very active in expanding and consolidating its activities with the idea of reaching the maximum number of people interested in the electrical phases of the problems involving the industries within the scope of this committee. Since the AIEE membership in these industries is still comparatively low, it has been decided that for maximum effect we must bring our message to these people by conferences in strategic locations, rather than present our programs, generally, at regularly scheduled AIEE meetings. The interest in these conference-type meetings has grown tremendously and there is a steady flow of applications for AIEE membership from these industries.

Pacific Coast Subcommittee is now an active group and has presented a group of technical papers at several of the General meetings within that area. They are actively co-operating with the several Sections. They are also working jointly with the Materials Handling Subcommittee in the arrangements for a Materials Handling Conference on the West Coast in the near future.

Materials Handling Subcommittee is again a most active group and after being dormant for several years, held a conference in Cleveland on overhead cranes with an attendance of nearly 300. This subcommittee is planning yearly conferences and will cover various phases of materials handling and schedule the conferences at locations where a maximum number of people interested in the particular phase to be discussed are located.

Paper and Pulp Subcommittee has also been reactivated and held its first conference in St. Petersburg, Fla. The interest has been most encouraging and certainly one and possibly two conferences are planned for the next year.

Machine Tool and the Rubber and Plastics Subcommittees have both held their usual successful conferences. These conferences have attained the status of being indispensable to these industries and have nation-wide attendance.

Textile Subcommittee, in addition to two conferences and three sessions at AIEE meetings, has prepared a publication, "Recommended Electrical Practices in the Textile Industry." This will be presented at a session at the Summer General Meeting and this has been the result of 5 years of study and data collection. It has been through the efforts of this subcommittee that the National Electrical Manufacturers Association has reclassified control enclosures.

COMMITTEE ON INDUSTRIAL CONTROL

Two meetings of the Industrial Control Committee were held during the past year; one during the Chicago Meeting in October 1954 and the second at the New York Winter General Meeting in February 1955.

At the Fall General Meeting in Chicago a technical session was sponsored on the subject of automatic controls. At the Winter General Meeting in New York, the committee sponsored two technical sessions, one on automatic controls and the other on general control problems, which included a paper on safety. There was so much interest in the paper on safety that it was decided to sponsor a complete session on safety at the Fall General Meeting in 1955. It was apparent that there were a number of facets to the subject of safety in industrial control equipment. One important one is the safety features incorporated in controls to protect both men and machines. Another important subject relates to the adequacy of the control when connected to large power systems.

Subcommittee on Test Codes has submitted for comment a draft of a proposal on test codes for use by manufacturers and testing agencies. It is hoped that all comments will be received and that the final draft can be submitted to the appropriate body for adoption.

Subcommittee on Electronic Control has been extremely active during the past year establishing rating and testing standards for electronic motor controls. It is hoped that this work will be in final form by the end of 1955.

Subcommittee on Regulators and Feedback Control Systems is active in an American Standards Association (ASA) committee established to clarify the confusion that now exists between the various industries that use the feedback control principle

COMMITTEE ON INDUSTRIAL POWER RECTIFIERS (COMMITTEE ON ELECTRONIC POWER CONVERTERS)

During the past administrative year, this committee has been transferred from the Science and Electronics Division to the General Industry Division and its name has been changed. The new title is more descriptive of its major field of activity.

The committee sponsored one technical session at the 1955 Winter General Meeting. This session was well attended.

International Electrotechnical Commission (IEC) Standards. The Joint Working Group of ASA Sectional Committee *C-34* of the Electronic Power Converter Committee prepared a report on recommended modifications of the 1954 IEC Draft Standards for guidance of the American delegate to the 1954 session of IEC Committee *22* on power rectifiers at Philadelphia, Pa. The chief American delegate to the committee was ably assisted by associate delegates selected from the Electronic Power Converter Committee. The viewpoints expressed by these delegates, particularly the user group, were influential in resolving differences between the American and European viewpoints. Much progress was made in resolving the differences in viewpoints and there is a good possibility that the resulting draft, which is to be edited and circulated for approval under the Six Months' Rule, will be accepted.

Revision of ASA C-34 Standards. This project had been delayed, pending resolution of differences in viewpoint among the nations represented on IEC Committee *22*. These differences appear to have been resolved, and the forthcoming IEC recommendations will constitute an acceptable base for modification of the existing ASA standards. The working group on revision of *C-34* standards has gone into action and further meetings are scheduled to finish this task.

Working Group on Protection of Electronic Converters. The activity of this working group has resulted in one technical paper to date by two members of the group. Further work will be required before the group can prepare its report.

Standards for Hot-Cathode Power Converters. The scope of this committee has been modified so that responsibility for hot-cathode power converters now lies in the Electronics Committee. The subcommittee which has been working on the standards for hot-cathode power converters is continuing this work and will henceforth report to the Electronics Committee.

COMMITTEE ON INDUSTRIAL POWER SYSTEMS

This committee held two meetings and six technical sessions this year, five being joint sessions.

Two of the joint sessions pertained to higher distribution voltage in metropolitan areas and the ten papers involved were printed in AIEE Special Publication *S-66*. One joint session was held with the Textile Subcommittee at a special technical conference.

The organizing and conducting of technical sessions by committee member assignment for the purpose of spreading of committee activity and personnel development is working very well and is being continued with assignments made to the Winter General Meeting of 1957.

Pacific Coast Subcommittee is performing its functions of developing the technical sessions held on the Pacific Coast, working with the other subcommittees on projects and providing representation at the main committee meeting.

Industrial Grounding Subcommittee is in the stage of reviewing comments arising from approval considerations of the Standards Committee for the publication of a "Recommended Guide on Grounding of Industrial Power Systems."

Electric Power Distribution for Industrial Plants Subcommittee is reviewing the Industrial Power Systems Committee's comments and obtaining committee approval before submission to the Standards Committee of the proposed revision of the "Red Book, Electric Power Distribution for Industrial Plants."

Distribution Systems for Commercial Buildings Subcommittee has organized a Guiding Committee and ten chapter working groups for the revision of the "Green Book." The revision will be considered as a Recommended Guide by the Standards Committee under the title of "Distribution Systems in Commercial Buildings."

COMMITTEE ON MINING AND METAL INDUSTRY

Committee activities during the past year have been devoted almost entirely to the organization and presentation of technical papers at General meetings.

Metal Industries Subcommittee has carried on co-ordination activity with the

Association of Iron and Steel Engineers (AISE), the objective being to reach informal agreement on proper scope of AISE and AIEE with respect to technical paper coverage.

Eastern Mining Subcommittee has continued close liaison with the Underground Power Committee of the American Mining Congress (AMC), and several persons participating both in AIEE and AMC have assisted materially in this endeavor.

Committee on Mining and Metal Industry has placed increased emphasis on technical papers of high quality. It is believed that the AIEE papers should be directed primarily toward electrical engineers in the mining and metal field, whereas papers prepared for AISE and AMC should be less technical in nature from an electrical standpoint and should be directed principally toward operating and management people in the industries.

COMMITTEE ON PETROLEUM INDUSTRY

The first major endeavor of this newly formed committee was the holding of the Electrical Conference of the Petroleum Industry in Tulsa, Okla., September 27–29, 1954. The conference was very successful, with a registration of 389 including representation from 22 states and Canada. The program consisted of 19 papers with four on refinery application, seven on pipe-line subjects, six on oil and gas production, and two general-interest papers.

A 4-paper technical session was held at the Winter General Meeting.

Active subcommittees were organized to cover the three principal phases of the petroleum industry: production, refining, and transportation.

Most of the committee's effort has been directed to organizing the second Electrical Conference of the Petroleum Industry to be held in Houston, Tex., September 12–14, 1955.

Power Division

COMMITTEE ON CARRIER CURRENT

The committee sponsored technical sessions and also held committee meetings at the Summer and Pacific, Fall, and Winter General Meetings. The main purpose of the summer committee meeting at Los Angeles was to stimulate the interest of the West Coast members in committee activities. The technical session at the Fall General Meeting was a symposium on microwave, at which time both users and manufacturers of microwave equipment informally presented items of general interest so that others at the meeting could profit by their experience. This symposium was well attended, and there was good participation in the discussion. Technical sessions on carrier and microwave are also planned for the Summer and Fall meetings.

Executive Subcommittee. This subcommittee has the continuing function of assisting the chairman. In view of the increased microwave activity of the committee, the executive subcommittee is drafting a revised scope and committee name to be presented for approval at the Summer General Meeting.

Methods of Measurements Subcommittee. The members of this subcommittee have laid out an extensive field test program for the summer of 1955. From an analysis of the results obtained, it is expected that preferred procedures can be set up for obtaining the carrier-frequency characteristics of power and carrier equipment.

Microwave Subcommittee. The Microwave Subcommittee organized and conducted the microwave symposium held at the 1954 Fall General Meeting in Chicago. The next project is to compose and send out a questionnaire to obtain field data on microwave installations.

Carrier Bibliography Subcommittee. This is a continuing activity to obtain a complete record of the literature on power-line carrier and microwave. A new bibliography through December 1954 will soon be finished to cover the literature since the last report (1951).

Standards for Carrier Radiation. A draft of the proposed standards for limits and measurement of carrier radiation has been written by this subcommittee and circulated for comments. The final report will be presented to the committee for approval at the 1955 Summer General Meeting.

COMMITTEE ON INSULATED CONDUCTORS

During the year the committee sponsored six technical sessions at the Summer, Fall, and Winter General Meetings. The committee also sponsored, jointly with the Committee on Transmission and Distribution, two sessions at the Pittsburgh Conference on the Electrical Utilization of Aluminum. The committee reviewed a number of papers and 26 were scheduled for meetings during the year. In addition, 11 papers and three sessions have been scheduled for the 1955 Summer General Meeting. The sponsorship of the sessions at the General meetings and at the technical conference resulted from the basic work of the committee which was carried on at two 2-day meetings held in New York, N. Y., in November 1954 and in Cleveland in April 1955. In both cases individual meetings of the various subcommittees were held on the first day, followed by a general meeting of the entire committee on the second day. The activities of the committees have been carried out under an organizational setup consisting of 13 subcommittees on administration, standards and publications, cable characteristics, conductors, insulations, sheaths and coverings, cable supply systems, utilization wiring systems, special-purpose cable, accessories, structures, tests and measurements, and European practice. Initiated at the start of the 1953–54 administrative year and including in its roster representation from a number of countries abroad, the European Practice Subcommittee has provided an important liaison channel between the committee and the European members of the subcommittee and is to be continued as a permanent part of the organizational setup. Recently a new Soil (Thermal) Resistivity Project Subcommittee has been formed to provide advisory technical guidance on a 3-year $65,000 cooperative research project which is being sponsored by AIEE, Engineering Foundation, Edison Electric Institute, Association of Edison Illuminating Companies, Insulated Power Cable Engineers Association, certain governmental and municipal agencies, and a number of interested cable manufacturers in the United States and Canada, and administered by a steering committee composed of four members representing the sponsoring organizations or groups. The life of this project subcommittee is to terminate on completion of active research work on the project.

Classified Bibliography on Insulated Conductors. An AIEE Special Publication (*S-73*) entitled "Classified Bibliography on Insulated Conductors" became available in March 1955. This bibliography lists all important technical articles on insulated conductors published in English from 1930 to 1954 in 14 technical journals and five miscellaneous publication groups. This publication was prepared and published under the guidance and direction of the Standards and Publications Subcommittee of the Committee on Insulated Conductors. This project was initiated in 1949 and at that time it was the intention to prepare a conventional bound list of references classified by subject matter and subclassified by publication in a manner similar to that utilized in the bibliography published in the National Electric Light Association "Underground Systems Reference Book" and covering prior literature up to 1930. However, on further study the subcommittee decided to adopt a loose-leaf format which classifies the reference involved by year and by publication and which at the same time provides a unique method of classification by subject into both main and subclassifications. The new format has the very important advantage of permitting the bibliography to be kept continuously up to date by the issuance at yearly intervals of a few pages which are identical in format to those of the original publication. The yearly supplement for 1954 is now in preparation by the Standards and Publications Subcommittee.

Flow and Pressure Calculations for Pipe-Type Cable Systems. The pipe-type cable hydraulics task group of the Cable Characteristics Subcommittee completed and presented a report at the 1955 Winter General Meeting on "Oil Flow Calculations for Pipe-Type Cable Systems." This report embodies a large amount of theoretical and experimental work carried on by the task group over the past 5 years in an effort to develop practical methods for the study and determination of those factors associated with or related to the hydraulic aspects of high-pressure high-voltage pipe-type cable systems employing oil as a pressure medium. This report constitutes the first comprehensive treatment of the subject which has been published to date.

Thermal Resistivity Characteristics of Soils. Over the 7 years of its existence, the Committee on Insulated Conductors has sponsored and presented a number of reports providing notable advances in methods and assurance for the more accurate determination of the current-carrying capacity of underground cable systems. Some 3 years ago, a task group of the Cable Characteristics Subcommittee was assigned the problem of investigating one of the few remaining factors on which fundamental data are still lacking, namely, the thermal resistivity characteristics of soils. In April 1954, the task

group reported that their study had disclosed the existence of a peculiar phenomena of instability of soil thermal resistivity under certain conditions suspected to be related to soil type, moisture migration characteristics, etc., stated that a fundamental understanding of the phenomena was essential to further progress, and recommended that a 3-year research program be undertaken. In conformance with this recommendation the committee, during the year, took the steps necessary to obtain sponsorship from interested groups and organizations for a co-operative research project and have completed arrangements for an organizational setup for administering and providing practical and technical guidance for the project. Active work on the project is expected to begin early in the new fiscal year.

Limiter and Cable Application and Coordination on Secondary Network Systems. For the past 5 years a limiter standardization task group of the Accessories Subcommittee has been conducting an active re-examination and re-evaluation of the design factors, function, application, and co-ordination of limiters and cable for use on low-voltage a-c network distribution systems. The results of this investigation are included in a group of eight papers to be presented at the 1955 Summer General Meeting.

COMMITTEE ON POWER GENERATION

Three committee meetings were held during the year, one at each of the Institute General meetings. Technical sessions were also sponsored at all of the General meetings; these sessions covered such areas as station design, hydroelectric systems, and excitation systems.

During the year changes were made in the main and subcommittee scopes in order that these scopes would be in line with the present work of these groups. The main committee scope was enlarged to include nuclear power. Interest in this rapidly expanding field is evidenced by the recent application to the Atomic Energy Commission by four electrical utilities for permission to construct nuclear power plants of significant size. The Speed Governing Subcommittee has been renamed the Prime Mover Control and Protection Subcommittee, and its scope has been enlarged accordingly. At the request of the Pacific Coast Subcommittee, this group has been disbanded. It is felt that the diverse interests of the Pacific Coast members can best be satisfied not by a common Pacific Coast Subcommittee, but by active participation in the subcommittees assigned to the particular interests.

Prime Movers Control and Protection Subcommittee. The subcommittee activities are, in many cases, joint with the System Controls Committee of the Committee on System Engineering and has been functioning in this manner for the last year towards following the technical activities in the field of automatic-frequency–tie-line control. The Governing Subcommittee will continue in this joint sponsorship of papers following such activities.

Excitation Systems Subcommittee. Interest in the operation of synchronous condensers and generators in the underexcited region is growing because operating conditions of present-day transmission systems frequently require it. This subcommittee sponsored a technical session which reviewed underexcitation limiting devices for voltage regulators and the operation of synchronous condensers with negative field excitation. In addition to this activity, work on excitation system definitions is continuing.

Hydroelectric Systems Subcommittee. This subcommittee had an active year with one meeting during the 1955 Winter General Meeting. Three papers were presented at the 1954 Summer and Pacific General Meeting dealing with nondestructive testing of mechanical components, performance of thrust bearings for vertical units, and operation for optimum income. At the Winter General Meeting two papers covered modern procedures in installation. The subcommittee has a working group actively pursuing the study of operating and maintenance experience with thrust bearings for large units.

Application of Probability Methods Subcommittee. The subcommittee presented a report on the forced outage rates of high-pressure turbines and boilers for the 3-year period 1950–52 at the 1954 Fall General Meeting. It is continuing to collect additional data for subsequent years which it is expected will be published from time to time as warranted. It is hoped to investigate soon the possibility and desirability of collecting similar data for transmission and distribution circuits and appurtenances and transformers, and for various generating station auxiliaries so as to provide a factual basis for the application of probability methods to all the elements of power systems.

AIEE-ASME Joint Committee on Recommended Specifications for the Speed Governing Prime Movers. The previous committee has been disbanded, and a new committee has been organized under the chairmanship of W. C. Astley of The American Society of Mechanical Engineers. One of the first items of business for the new committee is known to be a review of the recommended specifications for the steam turbines. This review will take into account the new maximum rating method of rating steam turbines.

COMMITTEE ON PROTECTIVE DEVICES

The committee sponsored a technical session at the 1954 Fall General Meeting in Chicago and had a joint session with the Committee on Transmission and Distribution at the 1955 Winter General Meeting. A technical session will also be sponsored at the 1955 Summer General Meeting.

The three grounding guides ("Guide for Application of Ground Fault Neutralizers," "Application Guide for the Grounding of Synchronous Generator Systems," and "Application Guide on Methods of Neutral Grounding of Transmission Systems") have been published as committee reports and are available as Report no. *954*.

Fault Limiting Devices Subcommittee. The working group preparing the report on "Factors Concerned With the Use of Protective Devices Shunting Current Limiting Reactors" has completed investigations on the protection of both series reactors and neutral grounding reactors, and a final report will be presented at the Summer General Meeting.

A working group has been organized for the revision of AIEE Standard *32* on neutral grounding devices. The working group has completely reviewed the existing standard and expect to have the first draft of the revision in time for the Summer General Meeting. The standard is to be arranged in the form of publication adopted by the American Standards Association (ASA). The working group on reducing the resistance of grounding systems has completed its organization, and a program for action has been prepared.

Lightning Protective Devices Subcommittee. The "Revised Report on Standards for Valve and Expulsion-Type Lightning Arresters," no. *28B*, has been approved by the subcommittee and has been submitted to the Protective Devices Committee for its approval to send to the Standards Committee. ASA Sectional Committee *C-62* is actively engaged in revising the American Standard for Lightning Arresters.

The investigation of switching surges is being undertaken as a joint effort by representation on a working group of the Transmission and Distribution General Systems Subcommittee. Lightning arresters are involved in that the voltages may be high enough to sparkover the arrester gap and discharge long-duration surge currents. The arrester protective characteristics under such discharges determine the stress on apparatus insulation on long-duration voltages. The nature of the current discharge determines the duty on the arrester.

The working group on direct stroke shielding of substations has collected considerable data on this subject, but it is evident from the results of the questionnaire that information on the relative effectiveness in service of the different methods or practices on direct stroke protection is not available. The group is making a new evaluation of the data and a decision on future action will be determined.

Considerable work has been done on the preparation of the "Lightning Arrester Application Guide," but it was found very difficult to reconcile conflicting viewpoints on the material to be presented in the guide. It has now been decided that a committee report should be prepared rather than a guide. This report will encourage discussion by the major schools of opinion.

The working group on lightning protection of aerial cable has completed a questionnaire which is being sent to the users of aerial cable.

A working group on lightning protection of multicircuit substations is being organized. For a given assumed incoming surge to a station, the additional lines connected to the bus reduce the steepness of the front of the wave and effect the permissible distance between the arrester and the transformer. The added lines also reduce the magnitude of any incoming surge. The working group will review the status of the information on this subject and encourage more papers.

A working group on surge protection of rotating machinery is being organized, also. A number of papers have been written on this subject. The working group will study circuits and promote further papers until more information on insulation is available.

A working group is being formed to prepare a report on the "Lightning Protection of Dry-Type Transformers."

A working group will be organized on the subject of surge transfer through transformers. After organization, a program for action will be prepared.

A working group was organized to report on performance characteristics of valve-type lightning arresters. These data were compiled from information furnished by four manufacturers on their arresters and the data brought up to date information published in the previous report. This report was prepared for and has been forwarded to the chairman of the AIEE delegation to the Joint Committee on Insulation Co-ordination. This report must be regarded as a preliminary or interim report.

Co-ordination of Insulation Subcommittee. This subcommittee functions in a liaison capacity between the Protective Devices Committee and AIEE Standards Co-ordinating Committee *8*. The latter committee is studying and preparing a report covering recommended standard values of basic impulse insulation levels. In the course of the work of Committee *8* problems of co-ordination of insulation of the various types of apparatus are discussed. The progress being made in the establishment of standard values of basic impulse insulation levels has been reported by AIEE Standards Co-ordinating Committee *8* and is covered in *Transactions*.

COMMITTEE ON RELAYS

During the AIEE business year, the Committee on Relays normally holds three meetings when a review is made of the activities of each of the subcommittees and project committees. The latter are responsible for the active study of technical problems which they carry out by means of meetings of their own, augmented by correspondence. The main committee directs the undertaking of new working groups as necessary, and ultimately passing on the reports prepared by them. During the year 1954–55 this normal pattern was followed, with 2-day meetings held in September and April, and a half-day meeting in February.

Two new project committees were formed; one to study the general field of motor protection, and the other to prepare a review of relay protective practices in the United States and Canada, covering all fields. These groups are already well organized and have established the area of initial attack on their problems.

Two project committees were discharged following the presentation of their reports to the Institute; the Project Committees on Effect of Vibration and Shock on Relays, and Co-ordination of Construction and Protection of Distribution Circuits (joint with Edison Electric Institute). It is expected that in the future new groups will take up new problems in both these fields, building upon the work already completed by these project committees. For example, the Subcommittee on Line Relay Protection has enlarged its scope to cover the distribution field, and this subject will probably claim a large part of this group's attention during the next couple of years.

The effectiveness of the Committee on Relays is greatly enhanced by the initiative and activitity of those members located in the West and comprising the Pacific Coast Subcommittee. This group carries on its work in much the same way as the main committee, co-ordinating its activities with the latter, yet encouraging regional interest and first-hand contact with its members to an extent that would not be possible otherwise. In accordance with their past practice, this subcommittee is sponsoring technical sessions at the Pacific General Meeting in August.

Cumulating several years' study, a forthcoming publication will be made of a brochure containing papers dealing with transmission-line protection practices. These are all papers that have proved of value as reference material, and it is expected that their assembly in one publication will be a convenience.

The Project Committee on Co-ordination of Relay Protection of Industrial Power Systems With Utility Systems is now completing the chapter on relaying that is to be included in the forthcoming new edition of the "Red Book." With the completion of this, the project committee will return to its original and basic assignment of promoting better understanding and co-operation among industrial customers, equipment suppliers, architects, consulting engineers, and utilities in regard to the problems associated with relay protection.

As a result of a study made by the Project Committee on Relay Performance of Current Transformers based in large measure on questionnaires circulated in the industry, the Committee on Relays recommended the re-adoption of the 5-lead bushing current transformer which was standard prior to 1948 for 600/5 and 1,200/5 ratings; and to adopt a new 5-lead standard for the 2,000/5 rating. This recommended change in standard will be presented for action through the normal channels.

The Project Committee on Test Methods has reviewed responses to a questionnaire issued to 90 operating companies. A draft report comprising a survey of the test methods employing throughout the industry has been prepared, and will be ready for presentation to the Institute next year.

The Project Committee on Pilot Wires has been completely reorganized during the past year following the report issued 2 years ago. Its scope has been broadened to encourage co-ordination between relay and communications interests.

The Project Committee on Devices for Control of Load Shedding and System Separation, created less than 2 years ago, has completed a survey of the industry and has prepared a draft report which is now ready for review by the entire committee. The interest in, and need for, joint activity of the relay and system planning engineers is emphasized by this study. It is expected that further attention will be called to this work at the joint technical session scheduled for the 1955 Summer General Meeting between the Committee on Relays and the System Planning Subcommittee.

COMMITTEE ON ROTATING MACHINERY

Preparation and revision of standards relating to rotating machinery has continued to be the major activity of this committee during 1954–55. A new working group was established to prepare a code for the measurement of rotating machinery noise, a code which is urgently needed. This group will co-ordinate with the Subcommittee on Magnetic Behavior of the Transformer Committee and with Standards Co-ordinating Committee *6*.

Sponsorship of technical papers and sessions continued at a high level, particularly by the Subcommittees on Insulation, and Synchronous, Induction, and D-C Machinery. Efforts to divert much of this activity to to the Fall Meeting were successful, resulting in seven sessions at Chicago, and a reduction of from nine to seven sessions at the 1955 Winter General Meeting as compared with the 1954 Winter General Meeting. One session at the Conference on the Electrical Utilization of Aluminum was sponsored by this committee.

Synchronous Machinery Subcommittee. The working group preparing a "Guide for the Operation and Maintenance of Turbine Generators" is making excellent progress and it is hoped that the guide will be ready for ballot this year. The working group on revision of the "Test Code for Synchronous Machines," AIEE *503* reports satisfactory progress. A new working group on standardization of voltages for large generators reports its conclusion that it is not desirable to fix specific values at the present time.

Induction Machinery Subcommittee. The revised "Test Code for Polyphase Induction Machines," AIEE *500* has been published, and carries the additional designation of ASA *C50.20*.

D-C Machinery Subcommittee. The working group on revision of "Test Code for D-C Machines," AIEE *501* and the group preparing the proposed "Guide for D-C Short-Circuit Calculations" are making satisfactory progress with their respective assignments.

Single-Phase and Fractional-Horsepower Machinery Subcommittee. This subcommittee will be cosponsor of a special technical conference on the application of small motors to be held at St. Louis, Mo., in October.

The working group on AIEE *502*, "Test Code for Single-Phase Motors," has completed revising the code, which will be ready for ballot as soon as it is cleared by the Test Code Subcommittee.

Electric Coupling Subcommittee. Two meetings were held during the year. Most of the activity of this subcommittee has been preliminary work on a proposed standard for describing the characteristics and ratings of electric couplings, clutches, and brakes. Such a standard is not presently in existence.

Insulation Subcommittee. AIEE *1-C*, "Test Code for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery," issued for trial use in January 1954, is being revised in the light of experience with its use, prior to final adoption. The principal change is the addition of an appendix on d-c field-coil insulation evaluation. Preliminary model testing work is being carried on by a working group assigned with the preparation of a similar test code on evaluation of systems of insulating materials for form wound coils. A new working group has been established to study evaluation of systems of insulating materials for high-voltage coils for large machinery. Another group is continuing the work on insulation endurance testing.

A ratio of d-c to a-c high-potential test voltage for alternative field testing of large machinery by direct current was proposed after consideration by the subcommittee to the Synchronous Machinery Subcommittee of ASA *C50*, in response to a request from the latter.

The "Proposed Guide for Insulation Maintenance for Large Alternating-Current Rotating Machinery," AIEE *56*, was published for trial use in May 1954.

Test Code Subcommittee. This subcommittee co-ordinates the test code activities of the various subcommittees with the Standards Committee, ASA, and others. It has been particularly active during the year.

Publicity and Bibliography Subcommittee. Reports on committee activities appeared in *Electrical Engineering*, and a report of the committee's "Engineering Developments for 1954" was prepared for the January 1955 issue. Work continued on bringing the "Bibliography on Rotating Machinery" up to date.

Carbon Brush Subcommittee (Joint with Committee on Air Transportation and National Electrical Manufacturers Association). AIEE *504*, "Test Code for Carbon Brushes," has been revised as the result of trial use since publication in October 1953 and is ready for ballot.

Working Groups

1. *Per Unit Definitions*. This group has been relatively inactive during the year.

2. *Letter Symbols for Induction Motor Quantities*. This group has prepared two proposed standards: "Standards for Induction Motor Letter Symbols" and "Dimensional Symbols for Induction Motors." Both have been ballotted on favorably and referred to the Standards Committee.

3. *ASA Standards*. This group has maintained liaison with ASA activities in which it is interested. The proposal was made and received favorably at a committee meeting on February 3, that this group be combined with the Test Code Subcommittee in order to consolidate co-ordination of standards and codes in one subcommittee.

4. *Measurement of Rotating Machinery Noise*. This group has just been constituted and has nothing to report.

COMMITTEE ON SUBSTATIONS

The Committee on Substations sponsored one independent technical session at the 1955 Winter General Meeting and cosponsored another session with the Committee on Switchgear at this meeting. In addition the committee provided two papers for the 1955 Middle Eastern District Meeting.

Transmission Substation Subcommittee. This subcommittee has two working groups which are following the following projects:

Extra-High-Voltage Substations. In view of the rapid progress being made in the field of extra-high-voltage substations and the lack of standardization of many details, this working group is proceeding on the basis that the most service to the industry can be provided by the preparation of a bibliography on this subject. The group has prepared a list of 82 references to articles on extra-high-voltage substations, and expects to have it ready for issuance as a committee report in the near future.

Fire Protection and Fireproofing. This is a new working group that has been formed to consider the problem of fire protection and fireproofing in substations. At the present time this working group is in the organizational stage.

Distribution Substation Subcommittee. This subcommittee is continuing on two projects remaining from the previous year and in addition has undertaken one new project:

Location and Design of Distribution Substations in Residential Areas. This working group has prepared a report which is almost completed. The final disposition of the report is not yet determined but it will probably be available only from the committee on request.

Design and Utilization of Mobile Substations. This working group has circulated a questionnaire to learn the present-day practice of the industry. Good progress has been made toward the preparation of a report and it is expected that this report will be completed in the near future.

Grounding and Corrosion in Substations. This is a new working group that has been organized to study the problem of grounding and corrosion in substations. The work will be a continuation of that done by an earlier working group that presented a paper on the subject at the 1954 Winter General Meeting.

Conversion Substation Subcommittee. This subcommittee is continuing a study of the grounding of d-c switchgear housings and other problems related to conversion substations.

Automatic and Supervisory Control Subcommittee. A working group of this subcommittee presented the results of a questionnaire concerning supervisory control at the 1955 Winter General Meeting.

Work on the revision of section *B* of the 1948 "Report on Telemetering, Supervisory Control, and Associated Circuits" is being carried forward. This report is being revised to include the significant operating characteristics of supervisory systems rather than specific information concerning manufacturers' equipment.

The third draft of the revision of *C-37.2—1945*, the American Standard for "Automatic Station Control, Supervisory and Associated Telemetering Equipments" is being revised. It is expected that this will soon be ready for release.

West Coast Subcommittee. This is a new subcommittee that was organized during the year for the purpose of providing committee members on the West Coast with an opportunity to participate in the work of the main committee to a greater extent. The subcommittee has about 20 members and has taken an active interest in several projects of the committee.

COMMITTEE ON SWITCHGEAR

The committee is actively engaged in conducting technical sessions and preparing standards.

Technical sessions have been held at the Fall General Meeting, Winter General Meeting, and Summer General Meeting. This included eight sessions and 35 technical papers. The committee also sponsored two sessions and ten technical papers at the Conference on the Electrical Utilization of Aluminum held in Pittsburgh, in March.

Members of the committee participated in the meeting of the International Electrotechnical Commission (IEC) held in Philadelphia, in September. Much interest was shown in a special meeting at which members of the committee discussed the new method of rating circuit breakers and invited discussions by other members of this organization.

New standards for assembled switchgear and enclosed bus have been published as ASA *C37.20*, and AIEE *27*. Also ASA *C37.13-.14-.15* and AIEE *20* covering low-voltage air circuit breakers have been published.

The Committee on Switchgear has held two well-attended meetings, one in St. Louis, Mo., on November 18, 1954, and one at Hershey, Pa., on May 20, 1955. A number of meetings of the subcommittees and working groups also were held during the year.

Administrative Subcommittee. The subcommittee consists of the chairmen of all subcommittees under the chairmanship of the vice-chairman of the Committee on Switchgear. Its function is to keep the various standards, which are under preparation in the subcommittees, from developing conflicts. Meetings held before the Committee on Switchgear meeting aid in the preparation of subcommittee reports.

Switches, Fuses and Insulator Subcommittee. A number of projects are underway in this committee. (*a*) A working group is preparing test sections for Standards *22* and *25*. These test sections are nearing completion and will be submitted for approval as additions to the standards. (*b*) A working group is preparing a guide for the operation and maintenance of switches and fuses. This too is nearing completion and will soon be submitted to the Committee on Switchgear for approval. (*c*) A working group is considering revisions to Standard *22* to cover automatic grounding switches. (*d*) A working group is considering the preparation of a standard for fuses 600 volts and below. A comprehensive study of existing standards has been made and a standard that will include the modern current-limiting high-capacity fuses is contemplated. (*e*) A working group is studying the problem of ice testing of disconnecting switches. A guide has been prepared and questionnaires have been sent to operating organizations to collect experience data.

The main and subcommittee have begun a study of the effect of the proposed new method of rating circuit breakers on the ratings of disconnecting switches. This study is in its early stages.

Power Circuit Breaker Subcommittee. The working group on circuit breaker rating methods has completed its work of preparing a proposed new basis for rating circuit breakers. This proposal has received wide publicity through technical papers, trade journals, and by circulation to other standardizing bodies including the IEC. It has received much favorable comment. Submission to the Circuit Breaker Subcommittee

and the Committee on Switchgear will be delayed until further work can be completed on studying system decrement characteristics.

A special working group has been set up to study these system decrement curves and several meetings have been held on the subject. The large amount of work required is being done at unusual speed, and conclusion should be available at an early date.

This new method of rating power circuit breakers will require a new test code and a new application so that they will all be in agreement. Work on these and other changes that seem to be desirable to modernize the standards are being prepared.

This subcommittee is also preparing standards to cover the application of power circuit breakers to capacitor switching.

The subject of single-phase fault protection was discussed in a technical paper at the Winter General Meeting.

It is proposed to prepare standards covering generator neutral grounding circuit breakers.

Low-Voltage Air Circuit Breaker Subcommittee. ASA *C37.13-.14-.15* has been published covering the material in AIEE *20*. This subcommittee has three working groups: (*a*) A working group is studying a simplified method for calculating d-c short circuits and has made considerable progress. (*b*) A working group is preparing a standard for field circuit breakers for motors and generators. (*c*) A working group is studying existing standards for moulded-case circuit breakers with a view to preparing an AIEE Standard for these breakers.

Automatic Circuit Recloser and Sectionalizer Subcommittee. AIEE Standard *50* is being changed to include rating for devices which are held in the closed position during short circuits as part of their duty cycle. With this addition, it will be presented for approval.

Switchgear Assemblies Subcommittee. Standard *27* has been published as ASA *C37.20* which completes the work on this standard. "Guide to the Application of Metal-Clad Switchgear for Solar Radiation" has been submitted to the Standards Committee for publication for one year's trial use.

All subcommittees are making studies to determine how the new method of rating power circuit breakers, if adopted, will affect their standards.

COMMITTEE ON SYSTEM ENGINEERING

The committee had four meetings during year and sponsored sessions at the Summer, Fall, and Winter General Meetings. A total of eight sessions were sponsored, two of which were joint sessions with the Committee on Computing Devices and one of which was a joint session with the Committee on Power Generation. The work of the committee is assigned to seven subcommittees.

System Controls Subcommittee studies the development and application of automatic controls for the regulation of tie lines and frequency of interconnected systems. The subcommittee works with the Power Generation Committee and the System Economics Subcommittee as the scope of this activity overlaps these other committees. A questionnaire covering the application of automatic load control equipment is being prepared.

System Economics Subcommittee studies the development of procedures to evaluate line losses and co-ordination of economic schedules for operations of power systems. The work is closely co-ordinated with the System Controls Subcommittee. The application of computer techniques for the solution of operating problems is now active.

System Operations Subcommittee studies problems and developments associated with load-dispatching procedures, training, operation, and general problems of interconnected systems. A program covering pool accounting and economic evaluation of interconnections is in progress.

System Planning Subcommittee has divided its activities into project groups which are covering the following activities: arc furnaces, effect on system; load forecasting; relay problems, joint with Committee on Relays; planning practices; application of computing devices; generator economics, and miscellaneous planning studies. A committee report on "System Planning Practices" has been completed and programs covering load forecasting, relay problems, and application of computing devices are being prepared.

Probability Subcommittee, joint with Power Generation Committee. Activities are continuing on the compilation of equipment outage data.

Far West Subcommittee was organized in 1954 to provide a closer co-ordination with the Pacific Coast activities.

Administrative Subcommittee met in March to assist the chairman in the organization of the committee for 1955–56. This group provides the means to discuss matters affecting internal committee activities.

COMMITTEE ON TRANSFORMERS

The committee held two meetings during the past year. It sponsored technical sessions at the Summer, Fall, and Winter General Meetings.

The work of the committee is divided among six subcommittees.

Dielectric Tests Subcommittee. The "Proposed Test Code for Power Factor Testing of Power Transformers" which this subcommittee prepared was approved by the Standards Committee and published for trial use, AIEE *505*, January 1955. A similar test code for distribution transformers has been approved by the Committee on Transformers and will be submitted to the Standards Committee.

Revised tables of standard dielectric tests for dry-type transformers and dry-type shunt reactors, for instrument transformers, and for step-voltage and induction-voltage regulators have been approved by the Committee on Transformers and will be submitted to the Standards Committee.

Work on the switching surge strength of insulation continues with liaison with the Committee on Transmission and Distribution in order to establish standard switching surges for design purposes.

Some further changes in the test code on impulse testing are being considered. Also, consideration is being given to the preparation of a guide for methods of conducting impulse tests.

Insulation Life Subcommittee. A very active program of testing dry-type transformer insulations is being conducted under the sponsorship of this subcommittee. A transformer model was developed for these tests and a proposed test code has been prepared. This test code, together with papers covering the results of some of the tests, will be presented at a symposium at the Summer General Meeting.

A proposal to revise the table of temperature rise limits of transformers is being reviewed.

Proposed revisions of the short-circuit sections of ASA Standard *C57* were approved by the Committee on Transformers and have been approved and sent to ASA by the Standards Committee.

Work is progressing on revising the "Guide for Loading Oil-Immersed Distribution and Power Transformers" and on a "Test Code for Evaluation of Systems of Insulating Materials for Specialty Transformers." Other items under consideration include methods of making temperature tests on dry-type transformers and the establishment of uniform methods for measuring ambient temperatures.

Insulating Fluids Subcommittee. A "Proposed Guide for Evaluating, Reclaiming, and Inhibiting Insulating Oils" has been prepared and is being reviewed by the subcommittee. This guide will apply to circuit breakers as well as transformer oils. Liaison is maintained with the Committee on Switchgear and the Committee on Instruments and Measurements.

Magnetic Behavior Subcommittee. Work continues on instrumentation and measurement in connection with the transformer sound investigation. Field requirements are needed; however, since a joint project of Edison Electric Institute and the National Electrical Manufacturers Association has been formed to investigate this phase of the work, the Committee on Transformers will limit its activity to the instrumentation and measurement problems for the present. Liaison has been established with the Committee on Rotating Machinery in order to co-ordinate sound investigations and to eliminate duplication of work.

Performance Characteristics Subcommittee. Reactor and instrument transformer test codes are under preparation. Separate test codes for other equipment covered by the American Standards for "Transformers, Regulators and Reactors," *C57*, are to be prepared. Also, the need for standards for furnace transformers is being investigated.

The "Proposed Guide for Operation and Maintenance of Dry-Type Transformers" is being reviewed and will be revised.

An impedance-bridge method for loss measurement is being considered for inclusion in the test code.

West Coast Subcommittee. This is a new subcommittee formed in 1954 to insure broader participation of western AIEE members in standardization and other activities of the main committee. An organization meeting was held in Los Angeles in June 1954 and a second meeting was held in San Francisco in January 1955. It is expected that the activities of this subcommittee will

be beneficial to the main committee by obtaining the viewpoint of the western members.

COMMITTEE ON TRANSMISSION AND DISTRIBUTION

The committee held two meetings during the year. It sponsored sessions at the Summer, Fall, and Winter General Meetings, and papers were also presented at several District meetings.

Capacity Subcommittee. Work is proceeding on a bibliography on capacitors covering the years 1953, 1954, and 1955, and is expected to be ready for the Fall General Meeting in 1955. In further study of the problems of short-time voltage characteristics of capacitors, the working group is planning to send a questionnaire to a small group of utilities that have experience with overvoltage on capacitors in order to obtain more field data. A series of recommended changes in AIEE Standard *18* is being circulated within the subcommittee and these are expected to be finalized shortly to be incorporated in the next revision of the standard. A questionnaire is to be sent out to a group of utilities to obtain their experience on capacitor switching problems and it is hoped that a comprehensive report on this matter can be available for the Fall Meeting.

Description Subcommittee. Interest continues in the matter of using higher voltage for distribution problems and papers are being sponsored on studies that have been made comparing 4 kv and higher voltages for this situation. Careful attention continues to be given to the matter of 480 volts as a secondary voltage and papers are being encouraged on this matter.

General Systems Subcommittee. The working group on switching surges is very active and includes representatives from the Committees on Transformers, Protective Devices, Substations, and Switchgear. Agreement has been reached on defining the problem and on the types of studies that will be pursued. A bibliography of recent literature on the subject has been prepared. Initial studies are concentrating on the general field of switching surges resulting from opening transmission lines and the effect of transformer magnetizing impedances connected thereto and also the effect of protective devices characteristics. Studies of fault-location methods have resulted in a bibliography that will be presented shortly as a technical paper. The important work on arc deionization times for higher voltage circuits is continuing in co-operation with CIGRE (International Conference on Large Electric High-Tension Systems) Committee *13* which is active in this field.

Lightning and Insulator Subcommittee. Considerable material has been assembled on the impulse characteristics of insulators, wood and air in series, and it is expected that a committee report will be evolved which will add considerably to the information on impulse strength of wood. Work is continuing on the basic factors involved in the design of transmission-line insulation and information is being collected on the effect of contaminated atmospheres. Studies on the use of silicone on insulator surfaces in contaminated areas has resulted in conflicting information which is difficult to evaluate, but further data are being collected. The subcommittee is planning research and stimulation of papers in the field of radio and television interference. It appears that there is much interest in this problem and papers in this field would be very welcome.

Towers, Poles and Conductors Subcommittee. The subcommittee is planning a questionnaire on the subject of the basic physical design of transmission structures in order to assemble the thinking of the industry on this matter. The subcommittee is following closely the work of the American Society for Testing Materials on tests of wood poles and is making suggestions on additional information that would be of value to the industry. A new topic is the study of twin conductors on transmission lines both from the point of view of extra-high-voltage lines and also on medium- and low-voltage lines where increased thermal capacity is desirable. The matter of corrosion problems of line hardware is receiving attention and papers are to be stimulated in this field.

General. The committee is actively interested in ASA Committee *C-2* which is planning a revision of the "National Electric Safety Code." This committee is concentrating on lines exceeding 100 kv and is reviewing the matter of clearances for lines above ground, to the tower structure, and also clearances for wire crossing. Considerable progress is being made in co-ordinating the thinking of the various groups involved.

Science and Electronics Division

SCIENCE AND ELECTRONICS DIVISION COMMITTEE

The scope of activities of the Science and Electronics Division is particularly susceptible to the development of new committees based upon up-to-date proposals from the committees of the division. Thus in the last 2 years the Committee on Electronic Converters was transferred to the Industry Division; a group within the Basic Sciences Committee has proposed full committee status for the Dielectrics Subcommittee; members in the Committee of Basic Sciences and the Committee on Electronics have proposed a new committee on "Stereatronics" (to deal with important problems in solid-state materials and devices); and the Committee on Nucleonics has sought papers from several divisions of the Institute for the Nuclear Congress to be held in Cleveland in December 1955. These developments are a tribute not only to the alert members of the several committees, but also to the flexibility of the division organization of AIEE.

COMMITTEE ON BASIC SCIENCES

The committee has had an extremely active year. An indication of this activity can be obtained by considering that the committee has sponsored the presentation of approximately 35 *Transactions* papers and 45 conference papers, which include papers presented at the 1954 Winter Meeting through the 1955 Winter Meeting. Plans have been made to stimulate more activity in the basic sciences field on the West Coast by the formation of a West Coast Subcommittee. Besides this recently formed subcommittee, the Basic Sciences Committee has six other subcommittees.

Subcommittee on Magnetics. Continued interest in the many phases of magnetics has led the subcommittee to sponsor a special technical conference in Pittsburgh in June in co-operation with the American Physical Society and the American Institute of Mining and Metallurgical Engineers. The papers presented in this 3-day conference are concerned with various phases of the general subject of magnetics, including basic properties, ferrites, materials for magnetic amplifiers and for high-speed switching, permanent magnets, instrumentation, etc. A total of 72 papers are scheduled.

Basic Concepts Subcommittee. The Basic Concepts Subcommittee has sponsored several sessions of papers during the year. These papers concern themselves with the definition of voltage, the definition of magnetic vector potential, rationalization, and the actions of the International Electrotechnical Commission, concerning units.

Subcommittee on Circuit Theory. This subcommittee reports progress on a wide front on all types of circuit theory. In particular, progress can be reported in the following areas: (*a*) simplification of certain synthesis problems in linear bilateral network theory; (*b*) circuit stability problems; (*c*) new solutions of certain problems in nonlinear circuits, transistors in switching circuits; and (*d*) the use of special algebras in the design of switching circuits.

Subcommittee on Applied Mathematics. This subcommittee has been active in sponsoring symposia on mathematical subjects. A conference on fields was sponsored at the 1955 Winter General Meeting.

Subcommittee on Semiconductors and Transistors. This subcommittee has sponsored a considerable number of sessions dealing with developments in the fast moving field of semiconductors and transistors at all of the recent national meetings of the Institute. Because of the widespread interest in this subject, sessions are also planned for several District meetings. Among the outstanding developments in this field during the year are: (*a*) the development of the *p-n-i-p* transistor which is especially adapted for high frequencies up to 600 mc; (*b*) improvements in construction of transistor tetrodes has led to raising the upper frequency limit to about 1,400 mc; (*c*) the reduction of noise to almost its theoretical lower limit in junction transistors; and (*d*) general advances in semiconductor technology in the areas of silicon and germanium.

Subcommittee on Dielectrics. This subcommittee has been very active during the year in sponsoring a considerable number of papers dealing with such matters as insulation evaluation, gaseous, liquid, and solid dielectrics. The subcommittee also has been very active in developing test procedures for the thermal evaluation of insulating materials and developing basic information to enable the rational revision of AIEE Insulation Standard *1*. The first of a series of test codes on insulation evaluation is now in the hands of the Standards Committee for final approval. Because of the widespread activity and growing interest of this sub-

committee a proposal to advance the subcommittee to full committee status has been submitted to a letter-ballot by the Science and Electronics Division Committee.

COMMITTEE ON COMPUTING DEVICES

Acting for the AIEE as cosponsor of the Joint Computer Committee of the AIEE, Institute of Radio Engineers, and Association for Computing Machinery, the Computing Devices Committee has participated in organizing and conducting two major computer conferences during the year. One of these held in Philadelphia, December 8–10, 1954, had as its theme "The Design and Application of Small Digital Computers," and featured an exhibition of applicable computers and components. The second conference in Los Angeles, March 1–3, 1955, covered "Functions and Techniques of Analogue and Digital Computers" and likewise was accompanied by an exhibit. Proceedings of both conferences are being published, these being the sixth and seventh respectively in a series of joint computer meetings held during the last 4 years.

The next Eastern Joint Computer Conference will be November 7–9, 1955, at the Hotel Statler in Boston, the subject being "Computers in Business and Industrial Systems." The next Western Joint Computer Conference is scheduled for San Francisco and the plans for it are progressing.

Subcommittees on Digital Computers, Analogue Computers, and Analogue-Digital Converters have been chiefly concerned with organizing technical sessions. A West Coast committee was formed to carry out similar activities in connection with meetings held on the West Coast.

One subcommittee is undertaking the problem of digital computer comparisons in an effort to evaluate the characteristics of computers as an aid in their application to problems of different classes.

It appears that the Computing Devices Committee may have an important part to play in a combined educational and application function to aid the industry in bringing into play the rapidly increasing power of the digital computer. A joint session is planned with the Committee on System Engineering on the use of computers in system planning problems and a joint subcommittee is being considered with this committee to survey the problems being handled or considered by various electrical utilities. Particular consideration is being given to handling these problems on digital equipment required in the utilities for accounting and other business purposes. Joint and analogue and digital applications are also receiving study.

COMMITTEE ON ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

The area within the scope of this committee continues to be a very active one. The many medical and electrical specialties represented cover a very wide range of subjects. In line with its long-range plans, major emphasis has been on the annual Conference on Electrical Techniques in Medicine and Biology jointly sponsored with the Institute of Radio Engineers and the Instrument Society of America. The technical program of this conference is of a high order centered around a series of symposia presented by authorities in the field under discussion.

The 1954 conference was held in Chicago. It is planned to hold the 1955 conference in Washington, D.C., in November. Preliminary plans call for field trips to Federal facilities where pertinent research is being done.

Among the techniques to be explored by the committee in the current year are those dealing with angiocardiography and amplifier-type hearing aids. In order to understand the basic design factors in these fields it is necessary that the engineer have an understanding of the physiology involved. Through its activities the committee hopes to make this information available to members of the Institute.

The membership of the committee is being expanded to include members from medical and biological specialties to serve as advisors in these areas. The willingness of these individuals to serve on the committee is evidence of the interest of these professions in the work of the Institute and this committee.

COMMITTEE ON ELECTRONICS

The activities of the committee during the past year were carried on primarily through its 12 subcommittees, 7 liaison committees, and the assignment of special projects to individual members of the committee. Each subcommittee has full responsibility for the planning and presentation of technical sessions in its field, and likewise, for participation in special conferences. The assignment of special projects has been very successful and has improved the operation of the committee greatly.

Proposed Committee on Solid-State Devices. The chairman of the Subcommittee on Semiconductor Devices brought to the attention of the committee the need for considering the future of the Institute in the very rapidly expanding field of solid-state devices. In addition to the work that is being done on semiconductor devices, such as the transistor, intensive investigational work is in progress on ferrites, ferroelectric dielectrics, photosensitive surfaces, and phosphors. It was suggested that the word "stereatronics" be considered as a suitable name for the field. After careful consideration, it was recommended that the proposal be presented to the Science and Electronics Division recommending the formation of a new committee to cover this field. This recommendation was favorably received by the Science and Electronics Division and a special group representing the committee concerned was appointed by the chairman of the Science and Electronics Division to prepare recommendations for submission to the Technical Operations Committee at the 1955 Summer Meeting. This work has been accomplished and it is hoped that the new committee can be established for the 1955–56 Institute year.

Subcommittee Activities. The scope of the Electronics Committee embraces a very wide field. In this field, there has been special activity in the following.

Major advances are being made in the X-ray field and particularly in the industrial use of X rays. The subcommittee in this field has brought to the Institute the first of a series of technical sessions covering the equipment and applications, and expects to proceed actively into work on standards.

The Electron Tube Subcommittee is investigating the possibility of an annual technical session, to be held at the Winter General Meetings, which would be devoted primarily to consideration of the development and design of electron tubes. A survey indicates that the particular field is not adequately or regularly covered by other societies or in the many special conferences. At the 1955 Winter Meeting of the Institute, two technical sessions were presented on the use of statistical methods as an aid in predicting the reliability and performance of electron tubes and circuits.

The field of semiconductor devices is expanding at a very rapid rate. The subcommittee in this field has been very active in planning technical sessions and has presented from two to three sessions at each of the last several Winter General Meetings of the Institute. In addition, work, in conjunction with the Institute of Radio Engineers (IRE), is in progress on standards. The work on definitions has been completed, and that on test methods is starting.

The Liaison Subcommittee on Electronic Aids to Navigation presented an outstanding program on transocean, continental, and local radar range and navigational systems. Marked progress has been made in improving the reliability and preciseness of the systems. Work is continuing in improvement studies, particularly on control and approach systems in the vicinity of airports.

Increasing attention is being given to electrostatic processes, particularly in the field of precipitation, and the status of this work was presented by the Subcommittee on Electrostatic Processes.

The Subcommittee on Electronic Circuits and Systems Engineering has continued the series of technical sessions to bring to the Institute the new work that is being done in this field.

The Subcommittee on Hot Cathode Converters is actively engaged in the preparation of standards and has completed the first phase of this work.

Technical Conferences. The committee has continued its policy of participating in special technical conferences usually in conjunction with other technical committees or other technical societies. This involved participation in (1) National Conference on Electronics; (2) National Conference on Components; (3) IRE–AIEE-sponsored Conference on Electron Devices; (4) IRE-AIEE Conference on Semiconductor Devices; (5) IRE-AIEE Transistor Circuit Conference.

COMMITTEE ON INSTRUMENTS AND MEASUREMENTS

The organizational structure of the committee, involving group subcommittees, has proved adequate to encompass the wide range of interests found in the technology of instrumentation. Expansion, in subcommittees, is anticipated and is being planned as required to meet the needs of new fields in science, new techniques in industry, or new patterns of engineering work. Responsibility has been delegated to the group subcommittees as performance has indicated ability effectively to promote and conduct the programs of the committee.

Group Subcommittee on General Activities. Continued progress has been made,

in the instrument portion of the ASA *C-42* project on definitions. Group *30*, "Instruments, Meters, and Meter Testing," has been reviewed and approved as well as Group *20*, "Apparatus for Scientific and Industrial Measurements." The work yet to be done consists almost entirely of editing, proofreading, and printing.

At the Philadelphia meeting of the International Electrotechnical Commission (IEC), three preparatory subcommittees, each presided over by a chairman of the corresponding Group *C-42*, put in final form for balloting three groups of IEC definitions: Electrochemistry and Electrometallurgy, Radiology, and Electrobiology. There were many compliments from foreign delegates on the work of the United States committees.

Group Subcommittee on Indicating and Integrating Instruments. A master test code for power measurements has been submitted to the Standards Committee. Complications in approvals have delayed issue but it is expected that it will be printed and placed in appropriate use in the near future. Collaborative study by interested American Society of Mechanical Engineers (ASME) committees is a liaison activity.

Review of ASA *C39.1* Instrument Standard has been completed and no need for radical changes was found. Minor clarifications in wording, all in the editorial processing stage, will bring this standard up to date.

Group Subcommittee on Recording and Controlling Instruments. Possibly the most important activity of the year was the participation in the First International Instrument Congress and Exposition held in Philadelphia in September 1954. Two sessions were sponsored by AIEE and the excellent attendance was evidence of the importance of such co-operative endeavors. The international aspects were also significant. It was particularly impressive to note the large number of industrial concerns which have entered at least a segment of this field. There was emphasis throughout the exposition on methods of data handling and reduction of data to log sheets.

Considerable progress has been made in the preparation of the detailed requirement sheets for the revision of a standard on recording and controlling instruments of the self-balancing type, ASA *C39.2*. Since much of the task depends on tests carried out by members of the subcommittee, the work will reflect contemporary techniques. The final draft of the proposed standard will be made ready for distribution to the members of the Sectional Committee.

Plans for a technical conference on recording and controlling instruments to be held in the Boston area have been initiated. The Instrument Society of America (ISA) and ASME participation will be solicited as was done at the special conference in Philadelphia 2 years ago.

The organizational meeting of ASA *C-85* on Terminology for Automatic Control was held in January 1955. Committee on Instruments and Measurements participation will help in accomplishing the task of defining terminology pertaining to fields known variously as control, feedback control, regulating, and other related systems not requiring human intervention as part of the regulating procedure.

Group Subcommittee on Electronic and High-Frequency Instruments. The fourth biennial Conference on High-Frequency Measurements was held in Washington, D.C., January 17–19, 1955. Four sessions and 24 papers made the conference a success.

Culmination of much work has resulted in acceptance by the Standards Committee of the recommended guides for specifications of (*a*) vacuum-tube voltmeters, (*b*) cathode-ray instruments, and (*c*) signal generators.

Other guides are being prepared or considered for power supplies, amplifiers and null detectors, and electrometer instruments. The necessity of a guide for specifications of accelerometers is being studied.

Work with ASA *C-63* Technical Subcommittee *1* has been active. The third draft of a proposed American Standards specification for radio noise and field-intensity meters 0.015 to 25 mc per second has been completed. Specification *C-63.3* covering measurements in the range 20 to 1,000 mc is out on provisional basis.

Group Subcommittee on Special Instruments and Auxiliary Apparatus. This group subcommittee has activities in diverse fields. One important phase is the measurement of dielectrics in the field. A guide for this work is progressing and will be available for committee review about the middle of this year. Six papers on this subject at the Winter General Meeting is a gauge of the interest.

A survey of the work and possible participation by AIEE in geophysical instruments and measurements is being made. This is an example of a specific interest in a specific geographical area that must be recognized if the committee is to keep up to date.

A separate publication of ASA *C-57.13* on Instrument Transformers alone is ready for publication. The group subcommittee has co-operated with the Insulated Conductors Committee on such projects as ionization level, electroendosmosis, radial power factor, and other measurement problems. The Subcommittee on Instrumentation for Resistance Welding has been active in defining the variables to be measured. When completed it is expected that the assistance of the Instruments and Measurements Committee will be solicited on recommended methods of accomplishing the measurements.

Group Subcommittee on Telemetering. The highlight of the telemetering year was the National Telemetering Conference of 1954 held in Chicago. Sessions lasted 3 days. This activity is sponsored by AIEE, Institute of Radio Engineers, Institute of the Aeronautical Sciences, and ISA. More than 33 papers were received after the conference started. Apparently, telemetering furnishes the stimulation for a conference per year. The 1955 conference was held in Chicago, May 18–20.

The subcommittee completed a "Glossary of Telemetering Terms." The "Telemetering Bibliography" has also been completed and has been accepted for *Transactions* publication. To fill out the further technical material available on telemetering, the AIEE 1948 "Report on Telemetering, Supervisory Control and Associated Circuits" is being revised and brought up to date.

Group Subcommittee on Nucleonic and Radiation Instruments. The Instruments and Measurements Committee serves jointly with the Committee on Nucleonics to cover this field of measurement.

Group Subcommittee on Navigation Instruments. The formation of a West Coast Subcommittee on instrumentation in aircraft is in the process of organization. AIEE participation in the Instrument Conference to be held in Los Angeles, September 1955, will be co-ordinated with ISA by this group subcommittee.

General. The committee sponsored the following technical sessions: Summer General Meeting, three sessions—five papers each; Fall General Meeting, one session—three papers; and Winter General Meeting, four sessions—17 papers, or a total of 35 papers.

A special task force has reviewed the procedures for preparing and processing technical papers for the committee and has prepared a discussion which may be submitted for publication.

COMMITTEE ON MAGNETIC AMPLIFIERS

The committee extended its coverage to include the allied field of dielectric amplifiers by the formation of a Subcommittee on Dielectric Amplifiers. However, it now appears likely that the activities of this subcommittee will soon be incorporated in a new Committee on Stereatronics which the Science and Electronics Division proposes be established.

This committee held two meetings during the year and sponsored a number of technical sessions at the Summer, Fall, and Winter General Meetings.

Most of the technical phases of the work of this committee are carried out by its seven subcommittees.

West Coast Subcommittee so encouraged the presentation of papers by West Coast authors that four technical sessions were sponsored at the 1954 Summer and Pacific General Meeting.

Applications Subcommittee continued its function of encouraging the submission of papers on applications of magnetic amplifiers. This subcommittee sponsored two sessions at the 1954 National Electronics Conference.

Definitions Subcommittee has prepared a progress report covering 140 terms listed under several categories. Before submission of these to the Magnetic Amplifier Committee for final adoption, this report is presently being circulated, along with a questionnaire, among a number of people associated with the magnetic amplifier art to ascertain whether or not the present usage of the terms is in general agreement with the proposed definitions. The rapid advances in the field of magnetic amplifiers make such a survey desirable.

Magnetic-Amplifier Theory Subcommittee has continued its study of the interrelation of magnetic-core properties and magnetic-amplifier circuitry. At a subcommittee meeting to which were invited the members of the Materials Subcommittee and several authorities on ferromagnetic phenomena and authors of pertinent papers, the following topics were discussed: (1)

the phenomena of magnetic domains; (2) the motion of domain walls and the resulting eddy currents; and (3) the factors influencing the speed of movement of the domain walls and the resulting relationship between the static and dynamic hysteresis loops of a ferromagnetic core.

Materials Subcommittee had developed a set of standards for presenting basic data on magnetic-amplifier core materials in 1951. These standards have recently been revised, put into final form, and formally submitted to the Magnetic Amplifier Committee for adoption on February 3, 1955. The main committee adopted these standards unanimously and suggested that they be presented as a technical paper at the 1955 Summer General Meeting. These standards are intended as a guide to manufacturers in presenting basic magnetic-core materials data and are not necessarily proposed as a test method for grading and matching magnetic amplifier cores.

Three working groups have been organized and are actively carrying out the work of this subcommittee.

The group on core matching and grading is studying the various methods now being used by manufacturers and users of core materials for magnetic amplifiers. Excellent response was had to a survey of some 50 such users and producers as to their core matching and grading techniques.

The group on basic core material tests is exploring the possibilities of supplementing the present standard sine-flux test by a constant-current flux reset test and a standardized half-wave self-saturated magnetic-amplifier circuit test.

The group on standardization of toroidal core sizes is drawing up several proposals for further consideration. This group has a difficult task and one which will require considerable time and effort to resolve.

A fourth working group on metallic rectifiers was formed and then soon dissolved upon the formation of the Subcommittee on Magnetic Amplifier Rectifiers of the AIEE Committee on Metallic Rectifiers. Some members of this working group became members of this new subcommittee.

Standards Subcommittee as reorganized has adopted the following as its scope: the preparation of proposed standards for magnetic amplifiers. In framing these standards, the chief purpose will be to define the terms and conditions which characterize the rating and behavior of magnetic amplifiers with special reference to the conditions and methods of testing. The dimensions or details of construction of magnetic amplifiers will not be standardized by these standards.

At a subcommittee meeting held during the 1955 Winter General Meeting, specific recommendations for methods of measuring the response time of magnetic amplifiers were considered. Additional specific recommendations for methods of measuring (1) voltage amplification; (2) current amplification; (3) zero stability; and (4) drift, are being prepared by various subcommittee members for consideration by the subcommittee at its next meeting.

COMMITTEE ON METALLIC RECTIFIERS

During the year, this committee's 11 subcommittees, which were appointed last year, became active and are now organized to the point where working groups have assignments and have made reports on their activities.

Subcommittee on Technical Information. The chairman of this subcommittee has submitted written reports on a technical subject pertaining to selenium rectifiers and is at the present time soliciting information from manufacturers on special applications which will be presented at a future meeting as information to the industry. Two new members, one from the Signal Corps and one from the Battelle Institute, have been added to this committee to enlarge the committee's technical background.

Subcommittee on Instrument Rectifiers. This subcommittee submitted its report during the last year and no new developments were reported during 1954.

Subcommittee on Standards. Standards on metallic rectifiers have been summarized and have been presented to the secretary of the AIEE Standards Committee and are presently being studied. If they are acceptable, they will be issued by the Institute.

Subcommittee on Bibliography. Work on the compilation of literature on metallic rectifiers has been begun and with the assistance of other members of the committee and industry as a whole, this work will be completed in a shorter time than would have been possible for one person to accomplish.

Subcommittee on Patents. This subcommittee has compiled a complete list of patents covering metallic rectifiers and the list is maintained up to date. The secretary has presented this list of patents to the Institute for consideration of publishing at some future date.

Subcommittee on Papers and Speakers. During the past administrative year, one technical session was held in Chicago at the Fall General Meeting and one is scheduled for the Summer General Meeting. At the Fall Meeting, three technical and two conference papers were presented, covering power germanium rectifiers, silicon junction diodes, a review of metallic rectifier standards for AIEE, and two papers on applications of rectifier units.

During the Summer General Meeting, it is planned to have a panel-type discussion of high-temperature rectifiers. This is a new venture for the committee in this type of presentation and considerable interest is anticipated.

Subcommittee on Semiconductors. This subcommittee has had several meetings and is fairly well organized. They will handle the June technical session.

Subcommittee on Metallic Rectifiers for Magnetic Amplifiers. This is a very active subcommittee as many of today's rectifier applications center around magnetic amplifiers. The chairman of this subcommittee has selected a large working group and has made considerable progress in establishing definitions which will be applicable to their type of work. This will assist them in working with the main committee and with other committees in the Institute where magnetic amplifiers are involved.

Subcommittee on Germanium Rectifiers. This is a newly formed committee and while little has been done up to the present time, the germanium rectifier is increasing in importance and promises to be a factor in the metallic rectifier business. It is apparent that special definitions and standards will have to be worked up for this new type of rectifier.

Subcommittee on Power Rectifiers. This is a newly formed subcommittee and their activity is to cover a revised scope so as to differentiate it from other full committees in the Science and Electronics Division. Part of the purpose of this subcommittee is to co-operate with the International Electrotechnical Commission (IEC) in Europe in their forming of metallic rectifier standards. The chairman of this subcommittee is also chairman of the IEC Committee *22-2*, which is their committee on metallic rectifiers. It will be part of the responsibility of this committee to determine to what extent we will co-operate with IEC in forming their standards for metallic rectifiers.

Subcommittee on Publicity. The chairman of this subcommittee is the vice-chairman of the Committee on Metallic Rectifiers. It has been his responsibility to get information to the Institute Headquarters regarding its activities and progress it has made.

General. The Committee on Metallic Rectifiers has shown considerable progress in the past 2 years as the activities have enlarged tremendously as compared to the past. This is due principally to the expanding use of metallic rectifiers in the electronics field and the entrance of two or three types of rectifying devices. The committee is so organized now that it can keep the Institute supplied with technical information as new developments reach maturity and other new ones appear.

COMMITTEE ON NUCLEONICS

The new subcommittee structure as revised last year has proved to be highly satisfactory. The Nuclear Machines Subcommittee sponsored a half-day session of five papers at the Winter General Meeting in New York. The West Coast Subcommittee arranged for 16 papers at last year's Summer General Meeting. One of the three sessions was jointly arranged with the Committee on Electrical Techniques in Biology and Medicine while the others covered reactors, instrumentation, and particle accelerators.

Two of the five conference papers (both on atomic power) presented at the Fall General Meeting on October 13 in Chicago have appeared since in *Electrical Engineering*. These papers were about equally divided between those falling in the purview of the Subcommittee on the Application of Nuclear Reactors to the Production of Power and the Subcommittee on Nucleonic and Radiation Instruments. Several technical papers were also presented at about this time. The Committee on Nucleonics again co-operated with the Committee on Electrical Techniques in Biology and Medicine in Chicago, November 10–11, where a field trip was arranged to see the large Cobalt 60 therapy units at the Argonne Cancer Clinic.

Each of the District meetings during the

past year have had at least one half-day session devoted to atomic power or atomic energy and instrumentation.

The Committee on Nucleonics' principal interest for 1955 centers on the forthcoming Engineers Joint Council (EJC) Nuclear Congress scheduled to be held in Cleveland, Ohio, December 11–15. About 12 papers will be provided by AIEE. Two members of the Committee on Nucleonics have been members of the EJC Program Committee.

Last year the Committee on Nucleonics after considerable study decided to endorse this EJC comprehensive nuclear meeting program. At that time, the American Nuclear Society had been proposed as an alternative. However, it was felt that interest in nuclear developments was so broad that it does and would continue to concern not only all phases of the electrical engineering profession but also to some degree virtually the entire membership of every professional scientific or engineering society. There would, it appeared, be an active role for the organization which could best find a common denominator for the nucleonics pursuits of some 20 to 30 active scientific and engineering societies. The EJC was singularly qualified to be that common denominator. This is witnessed by the fact that the sponsorship of the December Congress now includes not only EJC member organizations but many other societies as well. Among the latter group are the American Nuclear Society and the new Atomic Industrial Forum.

The great increase in interest cutting across all branches of engineering and science in subjects pertaining to atomic energy has resulted in a multiplicity of publications in technical journals and of meetings, both of a special nature and of committees of the various founding societies. This has caused considerable duplications of effort and inherent added expense. The Committee on Nucleonics is attempting to perform the two major roles of providing AIEE members with a source of latest developments in nucleonics and of encouraging fundamental basic progress by AIEE membership in atomic energy. In rendering these services, it must make a special effort to keep the ratio of technical accomplishment to administrative and organizational procedure at a maximum. This year should stand well because of the EJC Nuclear Congress participation in helping to provide the greatest technical good with the least logistical time in making meeting arrangements.

It is anticipated that the 1955–56 Institute year will witness an accelerating increase in interest in atomic power and applied nucleonics.

AWARDS

EDISON MEDAL

The Edison Medal for 1953 was awarded to John F. Peters, Consulting Engineer, Special Products Development Division, Westinghouse Electric Corporation, "for his contributions to the fundamentals of transformer design, his invention of the Klydonograph, his contributions to military computers and for his sympathetic understanding in the training of young engineers," and was presented to him on January 18, 1954, during the Winter General Meeting.

The medal may be awarded annually for meritorious achievement in electrical science, electrical engineering, or the electrical arts. Awards are made by a committee of 21 members of the Institute.

LAMME MEDAL

The Lamme Medal for 1953 was awarded to Frank A. Cowan, Director of Engineering, American Telephone and Telegraph Company, New York, N. Y., "for his outstanding contributions to long distance communication and the development of modulating and transmission measuring apparatus of original design and wide application." The medal was presented to him during the Summer and Pacific General Meeting.

The medal may be awarded annually by a committee of nine members to a member of the AIEE for "meritorious achievement in the development of electric apparatus or machinery."

HOOVER MEDAL

The Hoover Medal Fund was set up in order to provide a means of definitely recognizing outstanding civic or humanitarian services by a member of the engineering profession. The Hoover Medal Board of Award consists of 12 members, three each appointed by the four Founder Societies.

The 1954 medal was awarded to Alfred Pritchard Sloan, Jr., Chairman of the Board of General Motors Corporation, with the citation; "Engineer; builder of vast industry; friendly coordinator of management and labor; generous supporter of research in economics, education, and medicine; eminent citizen, exemplifying the finest traditions of American free enterprise."

CHARLES LE GEYT FORTESCUE FELLOWSHIP COMMITTEE

The availability of this award was brought to the attention of the department heads of electrical engineering schools in the country that offer accredited programs. Financial statements were reviewed by the committee members, and it was decided to grant one $2,000 fellowship for the year 1955–56. A total of 20 applications for the award was received. All applicants appeared to be well qualified.

The recipient of the award for the coming year is Taylor L. Booth of the University of Connecticut. Mr. Booth will do graduate work at the University of Connecticut in the automatic control systems field.

MARSTON MEDAL BOARD OF AWARD

This medal is presented annually at the commencement exercises of Iowa State College to a graduate of that institution who has achieved success in his field of engineering.

For the year 1954, the medal was awarded to Theodore V. Houser, recently elected president of Sears, Roebuck and Company.

ALESSANDRO VOLTA MEMORIAL

Through the effective co-operation of the committee appointed by the Italian Electrotechnical Association, headed by Professor Barbagelata of Milan, there continues to be excellent candidates for the annual award of the Volta Fellowship for 1 year of graduate work in the United States.

Recipient of the award for the current year is Fernando Amman, graduate of the University of Milan in 1952 and subsequently employed in research work in the Institute of Physics at Pisa. Mr. Amman received the award for 1 year of work under the direction of Professor Robert R. Wilson, director of the Laboratory of Nuclear Studies at Cornell University. He has done part of his work at Cornell and a part at the Synchrotron Laboratory of the California Institute of Technology. Mr. Amman expects to return to Italy this summer and to use the knowledge he has acquired here in helping in the design and construction of a large synchrotron in Italy.

Last year's Volta Fellow, Maurizio Vallauri, of Turin, who studied ultrahigh frequency and electronics at the Massachusetts Institute of Technology, was persuaded by the Institute to continue his research work there for a second year under a grant from the Institute. He intends to return to Italy this summer.

In view of the outstanding results which are being obtained and the rapid depletion of the fund by the current awards, the trustees in January recommended to President Monteith that arrangements be made for raising additional money for this purpose by application to a limited number of people who are particularly interested in relations between America and Italy.

WASHINGTON AWARD

The work of the Washington Award Commission for the year 1954–55 began with a luncheon held at the headquarters of the Western Society of Engineers (WSE) in Chicago on August 25, 1954.

At the meeting names of suitable candidates were presented and discussed. Subsequently several meetings of the Commission were held and ballots for the selection of a candidate for the award were sent out.

The winning candidate's name has not yet been announced.

The award is made, usually annually, to an outstanding engineer who must be a citizen, or resident, of the United States and who in his work has indicated great interest and concern in human welfare.

The Commission consists of representatives of the WSE, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, and the AIEE.

JOINT ACTIVITIES

UNITED ENGINEERING TRUSTEES

During the past year the United Engineering Trustees (UET) have continued to give attention and study to the problem of the proposed new Engineering Societies Building. Engineers and industries in several cities have organized local committees in an endeavor to attract the new building. The Trustees have been asked by the New York Committee for their opinion regarding the portion of that city which would be most suitable for the new building, as well as for information regarding space required, etc. These questions have been answered through the UET Real Estate Committee, which is available for similar consultation with other local committees.

As the governing bodies of the Founder Societies have indicated a desire to continue the Committee of the Five Presidents in

being, UET has expressed its desire to co-operate actively with that committee with a view toward reaching an early solution of the new building problem.

Engineering Foundation is a department of UET devoted to the stimulation of research by activating grants which are supplemented by contributions from industries and others. During the year Engineering Foundation instituted a record number of research projects and assumed the responsibilities of fiscal agent for two more Research Councils. Total grants through the fiscal year ending September 30, 1954, were $1,015,406 which stimulated contributions from others amounting to more than $6,750,000 for a total of 118 projects.

The Engineering Societies Library, a department of UET, contains more than 190,000 books, pamphlets, and maps. It receives regularly some 1,700 technical periodicals from all parts of the world. During the fiscal year recently ended the Library served a total of 38,095 people. More than a quarter-million words were translated from foreign publications and many hundreds of orders were filled for microfilms, bibliographics, searches, etc., in addition to making more than 63,500 photo prints. The income and cost of operating the Library amounted to about $130,000 during the year.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

AIEE has continued its strong support of the Engineers' Council for Professional Development throughout a very active year, AIEE chairmen directing many of its important committees.

The Guidance Committee has established guidance coverage of most of the high schools in the United States and Canada. A distribution of 35,000 folders, "After High School—What?" has been made. Vocational advice has been made available to practically every high school in the country. The Education Committee, which carries as its chief responsibility the accreditation of engineering colleges, has increased its inspections, at the same time collaborating with regional associations, to the end that more efficient accrediting procedures would be achieved. The Training Committee is at present engaged in establishing facilities for post-baccalaureate training in Detroit. Minneapolis is being studied as the location in the next step in expansion. The Ethics Committee, Student Development Committee, and Recognition Committee are engaged in their usual activities which include some joint work with National Society of Professional Engineers and Engineers Joint Council. The Information Committee is preparing to reprint the Wickenden "Professional Guide for Junior Engineers," the Canons of Ethics for Engineers, and separate lists of accredited engineering colleges and technical institutes.

ENGINEERS JOINT COUNCIL

Engineers Joint Council (EJC) continued its operation as a federation of eight societies, which increased to ten with the recent addition of American Society of Refrigerating Engineers and the American Institute of Industrial Engineers. AIEE has expressed its desire to see EJC develop into a more truly unity organization with "individual membership, adequately financed, and clothed with the power to act when necessary," and will continue to work toward that objective.

During the past year, EJC continued activities of broad interest to all engineers, expanding the work of Engineering Manpower Commission, initiating a Committee on Atomic Power, acting to work against legislation unfavorable to the engineering profession, and joining in co-operative efforts with UPADI, UNESCO, and other international engineering agencies.

The first EJC National Assemby was held in New York in January 1955, with forums on important subjects such as atomic power, manpower utilization, and education. This assembly was quite successful and well received, and will be repeated in 1956.

Plans are underway for a 5-day General Nuclear Congress to be held in Cleveland in December 1955.

REPRESENTATIVES

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

There was only one item of general interest to the Institute that came before the Council of the American Association for the Advancement of Science (AAAS) during the past year. This concerned the endorsement of a statement by the Board of Directors of AAAS on the subject of "Strengthening the Basis of National Security." The statement pertained particularly to the procedures for screening and clearing Government employees and other persons having access to classified information.

On review by and advice from the Executive Committee of AIEE, a negative ballot was cast for the AIEE. The basis for the negative ballot was that AIEE could not approve some of the specific modifications proposed in the statement by the Board of Directors of AAAS.

ATOMIC ENERGY COMMISSION ADVISORY COMMITTEE ON INDUSTRIAL INFORMATION

This committee has been constantly active in reporting to the Atomic Energy Commission information which would be considered valuable to industry if made available.

This year the committee was particularly active in recommendations relative to the "gray area" classification.

ENGINEERING SOCIETIES MONOGRAPHS COMMITTEE

There were only two manuscripts submitted during the year for consideration as possible monographs, but neither was of such kind to require review beyond what was done easily by correspondence.

GENERAL ELECTRIC EDUCATIONAL AND CHARITABLE FUND FELLOWSHIP PROGRAM

The General Electric Educational and Charitable Fund Fellowship Committee includes ten representatives from scientific, engineering, and educational organizations, and is charged with administering graduate fellowship awards in these fields under the Charles A. Coffin, Gerard Swope, Edwin W. Rice, Jr., and Owen D. Young Funds. There are 24 fellowships in all, six in each group, the latter two groups being newly established this year.

The committee met on March 28, 1955, and made 24 awards for the year 1955–56, selected from 237 applications. Ralph Bolgiano, Jr., Cornell University, 1944, and Robert E. Levin, Stanford University, 1953, are the recipients in electrical engineering. Additional General Electric Fellowships were awarded to candidates, including Ward D. Getty, University of Michigan, 1955, and Daniel N. Tompkins, Jr., Purdue University, 1955. All men indicated intentions of continuing graduate work at their respective universities.

NATIONAL BUREAU OF ENGINEERING REGISTRATION

Interest in this national certification of professional engineers is increasing. It is particularly advantageous for engineers who find it desirable to practice in several states.

NATIONAL ELECTRONICS CONFERENCE

The tenth annual National Electronics Conference (NEC) was held in the Hotel Sherman, Chicago, Ill., October 4–6, 1954, with an attendance of over 7,000. The program consisted of approximately 100 technical papers and there was an exhibit of electronic products in 168 booths.

The Monday luncheon was featured as the tenth birthday of the conference and included the first presentation of the NEC award for a paper presented at a previous conference which had exerted a strong influence on a major field in electronic science. The award went to E. D. McArthur and E. F. Peterson for their paper on the disk-seal tube presented at the first conference in 1944.

A number of AIEE personalities were invited to the luncheon and banquet on the second day of the conference, which is featured as AIEE–Institute of Radio Engineers Day. The Chicago Section of the AIEE is quite active in the operation of the conference and in support of the luncheons and banquets.

The 1955 conference will be held at the Hotel Sherman, October 3–5, 1955.

STANDARDS COUNCIL OF THE AMERICAN STANDARDS ASSOCIATION

The past year has been a particularly productive one in the annals of American Standards Association (ASA) history and has resulted in approval of 62 new standards and 79 revisions of existing standards. This brings the number of American Standards, as of February 28, 1955, to a total of 1,459. A goodly number of these fall directly in the electrical field, but, of course, many of the other American Standards are also of interest to AIEE. ASA has recently published a new price list, which is free upon request.

The Standards Council has considered a number of important matters during the past year. Among those of most interest to AIEE are the following:

1. Changes have been adopted in ASA procedure, relating to the approval of existing standards. There are indications that these changes are bearing fruit in the submittal of additional standards under the "Existing Standards Method."

2. The Standards Council has considered the suitability of standards for commercial arbitration, which were submitted for approval as American Standards by the American Arbitration Association. The Standards Council found that these were not suitable for approval as American Standards, and as a result of the discussion voted to form a special committee to report on the extent of the field to which standardization should be limited.

3. The Standards Council approved the policy that members-at-large on sectional committees be classified in accordance with their major interests in the work under consideration.

4. The Standards Council voted the policy that substantial balance with respect to interest shall exist among general classifications of members of sectional committees, except when the Standards Council determines that the sectional committee is concerned with matters of a scientific or noncommercial nature. This thus emphasizes the fact that a sectional committee will no longer be considered as of a scientific or noncommercial nature unless the sanction of the Standards Council is first obtained.

Arthur S. Johnson, vice-president and manager of engineering department, American Mutual Liability Insurance Company, has been elected chairman of the Standards Council, replacing J. R. Townsend, director, materials and standards engineering, Sandia Corporation.

UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

The year 1954 was an important one in the life of the International Electrotechnical Commission (IEC) since the Golden Jubilee of its founding in St. Louis in 1904 was observed at the general meeting held at the University of Pennsylvania in Philadelphia, September 1 to 16, 1954.

The meeting was the largest in the history of the IEC and was attended by more than 800 delegates from 21 nations. In addition, several hundred members of their families attended. The meeting was presided over by Dr. H. S. Osborne, president of the IEC, and the host on behalf of the U. S. National Committee was its president, R. C. Sogge. The organizational work for the meeting was under the general direction of P. H. Chase, vice-president of the U. S. National Committee.

Among the social functions held for the delegates was a welcoming reception at which the delegates were greeted by Dr. G. P. Harnwell, president of the University of Pennsylvania; Roger E. Gay, president of the American Standards Association; C. H. Linder, vice-president of the General Electric Company; and the city authorities.

A 2-day trip was provided for the delegates, with sightseeing in the city of Washington, and a visit to the National Bureau of Standards. These were followed by an official luncheon at which the principal speakers were the Honorable Harold E. Stassen, Director of the Foreign Operations Administration; the Honorable Samuel Spencer, President of the Board, District of Columbia Commissioners; and the Honorable Walter Williams, Under-Secretary of Commerce. The Washington trip was under the general direction of Dr. A. V. Astin, Director of the National Bureau of Standards.

Other social functions included a visit to the well-known Longwood Gardens, at which a concert was given by the Hampton Institute Choir. A number of tours and visits to points of scenic and historic interest in and around Philadelphia were arranged, including a typical American picnic.

Technical visits were arranged to a number of industrial plants in and near Philadelphia.

Jubilee Day was celebrated at two meetings at which the delegates were welcomed on behalf of the U. S. Government by the Honorable Charles E. Saltzman, Under-Secretary of State. The meeting was presided over by Dr. H. S. Osborne, and the speakers were as follows:

Dr. Hakan Sterky, Director General of the Swedish Telecommunications Systems: "Past, Present and Future Telecommunications Standardization"

Pierre Ailleret, director of research, Electricité de France: "Fifty Years of International Standardization in the Electrical Power Field"

Dr. Lee A. DuBridge, president of the California Institute of Technology: "Science and Electrotechnology"

The Right Honorable Viscount Waverley, past president of the British Standards Institution and chairman of the Port of London Authority: "International Economic Co-operation"

Jubilee Day was closed with a banquet at the Bellevue Stratford Hotel and was attended by 625 persons. AIEE President A. C. Monteith welcomed the gathering; Walker L. Cisler, president of the Detroit Edison Company, was toastmaster; and Don Mitchell, president, Sylvania Electric Products, Inc., delivered the main address: "Standardization, Foundation of International Progress." R. C. Sogge presided.

Following is a brief résumé of the technical work accomplished at the meetings of the 49 technical committees (TC) and subcommittees which were held. As a result of these meetings, 43 international recommendations were brought to the final stages of approval. These are more world standards than the IEC has produced in the previous 50 years.

TC1—Vocabulary. Work was continued on the revision of the International Electrotechnical Vocabulary at meetings of the Subcommittees on Electrochemistry-Electrometallurgy, Radiology, and Electrobiology.

TC2—Rotating Machinery. A revised version of the "Recommendations for the Classification of Insulating Materials" was agreed to. The U. S. National Committee will submit a revised edition of the AIEE "Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery."

TC4—Hydraulic Turbines. There was unanimous agreement on the urgent need for an international code covering rules for acceptance tests for hydraulic turbines.

The committee discussed three methods of water measurement. It was decided to include these three methods in a recommended IEC Code on hydraulic testing.

The secretariat will prepare a draft test code for hydraulic turbines for consideration by the committee.

TC5—Steam Turbines. As a result of this meeting a revised draft of the IEC "Recommendations on Steam Turbines" will be submitted to the national committees for final approval.

The general views expressed by the delegates will be incorporated by the secretariat into further revisions of IEC Publication *46* on "Rules for Acceptance Tests."

TC7—Aluminum. Agreement was reached on an International Standards of Resistance for Aluminum, Hard-Drawn Aluminum Conductor Wire, Aluminum Bus-Bar Conductors, and Galvanized Steel Core Wire for Steel-Reinforced Aluminum Conductors which will be put into draft form and circulated to the national committees for final approval.

The Committee of Action authorized TC *7* to begin work on a specification for aluminum alloy wires.

TC8—Standard Voltages and Currents. As the result of a request from the U. S. delegation it was decided that when a new edition of Publication *38* is prepared the proposal that 400 kv be added as nominal voltage corresponding to 420 kv in addition to 380 kv will be discussed.

In regard to equipment for voltages between 100 and 1,000 volts, TC *8* discussed and accepted definitions of "rated equipment voltage" and "maximum design voltage" proposed by the U. S. delegation.

It was also decided to send a questionnaire to the chairman of the Apparatus Committee on the voltages intended to designate equipment. The draft of this questionnaire was agreed on during the meeting.

A table of standard frequencies for different applications will be circulated to the national committees for comment.

TC9—Electric Traction Equipment and CMT. Modification to the 2d edition (1950) of Publication *48*, "Rules for Electric Traction Motors," were considered in detail and it decided that the third edition of Publication *48*, incorporating the changes agreed on at the meeting, could now be published.

Specifications for electric equipment installed on motor vehicles had been submitted to the national committees for approval previous to the meeting. The comments from the various countries were considered and it was decided that the first edition of this specification could now be published.

Rules for auxiliary machines on motor vehicles were discussed in detail. It is hoped that the work on this subject can be completed at the next meeting.

TC12—Radio Communication. As a result of the meeting of TC *12* and its subcommittees, it was agreed that the following documents would be circulated to the national committees for approval:

Recommended methods of measurement of receives for FM broadcast transmissions.

Safety requirements for mains-operated television receivers.

Supplement to Publication *65*—new clause regarding gramophone motors.

Supplement to Publication *65*—adjustment of voltage without the aid of tools.

Color code for ceramic dielectric capacitors.

Specification for type *1A* and *1B* ceramic dielectric capacitors.

Specification for aluminum electrolytic capacitors for general-purpose application.

Recommendations for characteristic impedances and dimensions R-F coaxial cables.

Specification for fixed paper dielectric capacitors.

Appendix I, color code for tubular paper capacitors.

In addition, a new subcommittee for radio transmitters was established.

Following a proposal from the U.S. National Committee, TC *12* and the Committee of Action agreed that Subcommittee *12-3* on Components for Electronic Equipment should receive the status of a separate technical committee, and that this new committee should take over the work on *HF* cables and crystals as well.

Work is to be undertaken on plugs and sockets for sound circuits of reproducing and modulating apparatus, color code for mica capacitors, radio-interference suppression capacitors, and coaxial plugs and sockets for television receivers.

TC15—Insulating Materials. TC *15* established seven working groups on the following subjects:

1. Dielectric strength test methods.
2. Volume and surface resistivity and insulation resistance test methods.
3. Tracking test methods.
4. Voltage endurance test methods.
5. "Encyclopedia" of insulating materials.
6. Dissipation factor and dielectric constant test methods.
7. Thermal stability test methods.

It is expected that progress can be made rather soon on all of these subjects.

TC17—Switchgear and Control Gear. Agreement was obtained on chapter III of the specification for a-c circuit breakers, dealing with rules for strength of insulation. After the document has been revised by the Editing Committee, it will be circulated to the national committees for final approval.

Consideration was given to the standardization of rated breaking capacity in relation to rated voltage and rated normal current of power circuit breakers. Provisional agreement was obtained and a new draft will be submitted to the national committees for examination at the next meeting.

The committee will deal with two further chapters of the specification for a-c circuit breakers, one on the selection and one on the maintenance of this equipment. Moreover, it will study a U.S. proposal for a new rating for short-circuit conditions and a U.S. proposal with regard to rules on overvoltages produced by circuit breakers when disconnecting lines at no load.

Recommendation of the IEC for apparatus designed to make and break circuits of a nominal voltage up to and including 1,000 volts alternating current and 4,500 volts direct current was considered and its scope and layout was modified. A second draft will be prepared for consideration at the next meeting.

TC18—Electrical Installations on Ships. This was the first meeting of the full committee since 1948, although work has been continued by correspondence by the subcommittees dealing with the different chapters of the "Code for Electrical Installations on Ships."

Sufficient progress was made during the meetings for a revised draft of the complete code to be prepared, and it is hoped that it will be possible to circulate this next year for final consideration.

TC19—Internal Combustion Engines. As this was the first meeting of this committee to be held since 1938, the discussions were limited to a consideration of general principles.

TC20—Electric Cables. A revised edition of the "Draft Specification for Tests on Impregnated Paper-Insulated Lead-Covered Cables" was agreed upon and will be circulated to the national committees for final approval.

TC22—Power Converting Equipment. A subcommittee has been formed to deal with dry-plate rectifiers, and agreement was reached on "Draft Recommendations for Mercury-Arc Converters."

TC24—Electric and Magnetic Magnitudes and Units. It was decided that the following decisions of the committee should be submitted to the national committees for final approval:

1. The name "Tesla" to be given to the quantity "magnetic flux density" in the Giorgi system.
2. The name "Giorgi system" to be given to the system of units based on the meter, kilogram, second, and ampere, although "mksa system" can also be used.
3. The positive sign to be given to reactive power in the sense of entering an inductive receiver.
4. The name "magnetization" to be given to the quantity $\frac{B}{\mu 0} - H$.
5. The name "magnetic polarization" or "ionic induction" to be given to the quantity $B - \mu 0\, H$.

A publication containing all the decisions taken by TC *24* will be prepared.

Resolutions regarding the rationalization of the electromagnetic field equations were approved.

It was decided to recommend that the Giorgi system should be used in all IEC publications and documents but that the use of cgs units should be permitted during the transitional period.

TC25—Letter Symbols and Signs. Work was started on an expanded revision of the 3d edition, 1953, of the Publication *27* on international electrical letter symbols.

The new edition will be greatly expanded in regard to material of interest in the electronic and telecommunications fields.

TC28—Insulation Co-ordination. Particular reference was made to the need for amplification of the definitions of insulated, effectively grounded, and noneffectively grounded systems.

An advisory subcommittee was set up to help the secretary in drafting an application guide for electric apparatus.

TC29—Electro-Acoustics. The following were approved for circulation to the national committees for final approval:

Audio apparatus, characteristics to be specified for application purposes.

Recommendations regarding magnetic-tape sound recording. Recommendations regarding lateral disk recording.

Recommended polarized plug for hearing aids.

Discussion of a method for measurement of electro-acoustical characteristics for hearing aids was commenced and will be continued at the next meeting.

TC30—Extra High Voltages. Questions concerning the precise conditions of voltages on systems working at or projected for 380 kv were discussed. It was decided that the maximum voltage will be fixed at the level of 430 kv instead of 400 kv as at present. No action was taken concerning the nominal voltage.

TC31—Flameproof Enclosures. A proposed "International Specification for the Construction of the Enclosures of Flameproof Electric Apparatus" was agreed to and will be circulated to the national committees for final approval.

TC33—Capacitors for Power Systems. It was agreed to publish as an IEC recommendation the "Specifications for Capacitors for Power Systems."

Agreement was reached that work should be started on coupling capacitors and potential dividers.

A "Specification for Series Capacitors for Power Systems" will be circulated to the national committees for approval.

TC34—Lamps and Related Equipment. A plan was formulated to enhance the accuracy of photometric and colorimetric measurements on fluorescent lamps. This plan involves the exchange of lamps between laboratories in several countries, and nine countries have already agreed to participate.

Proposals for a supplement to the IEC "Specification for Tungsten Filament Lamps for General Service" were agreed to and this specification will be circulated to the national committees for final approval.

A new subcommittee on luminaires is to be set up.

TC35—Primary Cells and Batteries. A new "Draft International Recommendation for Primary Cells and Batteries" was discussed and a certain number of amendments were agreed upon. A new draft will be prepared and circulated.

TC36—High-Voltage Tests—Insulators. It was agreed to issue as an IEC recommendation the "Draft Specification for Glass Insulators for Overhead Lines."

A new subcommittee was set up to deal with the standardization of ball and socket fittings for suspension insulators.

TC37—Lightning Arresters. The Experts' Committee of TC *37* held three full-day meetings during which the preparation of an international standard for lightning arresters of the nonlinear resistance type progressed.

TC39—Electronic Tubes and Valves. TC *39* decided that the following proposals should be circulated for final approval:

Dimensions of subminiature tubes and valves; bases and outlines.

Top caps for electronic tubes and valves.

Supplement to Publication *67*, part I, additional bases and gauges.

Supplement to Publication *67*, part II, new electronic tube and valve outlines.

It was also decided that a supplement to Publication *67*, part I, pin and index guide for duodecal and additional duodecal shell base, was ready for circulation.

TC *39* further decided that the following documents should be published as IEC recommendations:

Supplement to Publication *67*, part I, new electronic tube and valve bases.

Supplement to Publication *67*, part II, electronic tubes and valve outlines.

Committee of Action. It was confirmed that the 1955 general meeting would be held in London from June 28 to July 9, 1955.

It was agreed that work should be begun on the preparation of IEC recommendations covering the fundamental aspects of safety and like matters for electric apparatus.

It was decided to circulate a proposal concerning standardization of ambient temperatures specified during tests to the national committees for comment.

It was agreed to form a new subcommittee to prepare an international method for determining losses and magnetization in sheet steel for electrical purposes.

UNITED STATES NATIONAL COMMITTEE WORLD POWER CONFERENCE

During the past fiscal year the 1954 sectional meeting was held in Rio de Janiero and Petropolis, Brazil, July 25–August 10. This meeting was attended by the official delegate of the U. S. National Committee. Eleven papers by U. S. authors were presented. There were 46 U. S. citizens registered.

It was voted to hold the fifth plenary meeting in Vienna, Austria, June 16–23, 1956, and sectional meetings in Yugoslavia in 1957, Toronto, Ont., Canada, in 1958, and Switzerland in 1960.

The International Executive Council met and voted to increase the contributions of member countries.

The U. S. National Committee and Executive Board met in New York City, January 20, 1955. The treasurer of the Engineers Joint Council, custodian of the committee funds, submitted the financial report. The report of the task force on the review of the articles of association and bylaws was accepted and referred to the full committee for approval.

Recommendations were submitted for Group A members of the task force to solicit and review papers for the 1956 Vienna meeting.

APPRECIATION

The Board of Directors wishes to record its appreciation of the continuing excellent work of the general committees, the technical divisions and committees, and the District, Section, and Branch officers and committees. It also expresses its thanks to the membership for the widespread interest and participation in the activities.

Respectfully submitted for the Board of Directors.

N. S. Hibshman,
Secretary

MIDDLE EASTERN DISTRICT NO. 2

EAST CENTRAL DISTRICT NO. 11

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

67 BROAD STREET
NEW YORK 4

ACCOUNTANTS' CERTIFICATE

American Institute of Electrical Engineers:

We have examined the balance sheet of American Institute of Electrical Engineers, and schedule of securities owned, as of April 30, 1955, and the related statements of income and operating fund reserve and of restricted fund reserves for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet, schedule of securities owned, and statements of income and operating fund reserve and of restricted fund reserves present fairly the financial position of, and securities owned by, the Institute at April 30, 1955 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied (except for the deferment of uncollected dues, subscriptions, etc., as set forth in the note to Exhibit B) on a basis consistent with that of the preceding year.

(*Signed*) HASKINS & SELLS

New York,
May 25, 1955

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit A — **Balance Sheet, April 30, 1955**

ASSETS

Property Fund Assets:		
Founder's interest (one fourth) in capital assets of United Engineering Trustees, Inc.:		
Land, buildings, and equipment (less funded depreciation and renewal reserve)	$257,526.58	
Funded depreciation and renewal reserve	240,921.90	
Total	$498,448.48	
Other (at nominal value):		
Library	1.00	
Works of art, etc.	15.00	
Total property fund assets		$ 498,464.48
Restricted Fund Assets:		
Securities—at cost (quoted market value $988,179.96)—Schedule 1	$716,980.71	
Cash	31,129.95	
Accrued interest	237.59	
Total restricted fund assets		748,348.25
Operating Fund Assets:		
Cash	$ 48,041.95	
Accounts receivable:		
Members—for dues	24,374.75	
Advertisers	2,543.19	
Technical Conference loans	2,900.00	
Miscellaneous	23,901.82	
Accrued interest—reserve capital fund	2,597.67	
Inventories—at cost or less:		
Transactions	8,630.00	
Text and cover paper	1,553.69	
Badges	6,035.95	
Production charges for May issue of *Electrical Engineering*	23,627.45	
Other prepaid expenses	2,293.03	
Office furniture and fixtures (less reserve for depreciation, $50,519.26)	30,917.66	
Total operating fund assets		177,417.16
Total		$1,424,229.89

LIABILITIES

Property Fund Reserve:		
Founder's interest (one fourth) in capital assets of United Engineering Trustees, Inc.:		
Land, buildings, and equipment (less funded depreciation and renewal reserve)	$257,526.58	
Funded depreciation and renewal reserve (marketable securities and cash held by United Engineering Trustees, Inc.)	240,921.90	
Total (unchanged during the year)	$498,448.48	
Other (after transfer, $29,189.09, as of May 1, 1954 of office furniture and fixtures (net) to Operating Fund and write down, $2,986.35, to nominal value of works of art, etc.)	16.00	
Total property fund reserve		$ 498,464.48
Restricted Fund Reserves (Exhibit C):		
Reserve capital fund	$668,341.35	
Life membership fund	5,976.97	
Member-for-Life fund	20,698.90	
International Electrical Congress of St. Louis Library fund	6,619.04	
Edison Medal fund	9,878.99	
Lamme Medal fund	9,427.23	
Mailloux fund	1,036.67	
Volta Memorial fund	16,369.10	
Retired employees' insurance fund	10,000.00	
Total restricted fund reserves		748,348.25
Operating Fund Reserve, Liabilities, Etc.:		
Accounts payable	$ 67,347.13	
Deferred income, etc.:		
Dues (including $24,374.75 uncollected)	28,526.02	
Subscriptions to publications, etc. (including $17,820.70 uncollected)	48,037.16	
Operating fund reserve (Exhibit B)	33,506.85	
Total operating fund reserve, liabilities, etc.		177,417.16
Total		$1,424,229.89

Reference is made to note of Exhibit B.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit B — Statement of Income and Operating Fund Reserve for the Year Ended April 30, 1955

Income (see note):		
Dues (including members' subscriptions to *Electrical Engineering* and bimonthly publications)	$563,647.30	
Advertising in *Electrical Engineering*	341,060.79	
Transactions subscriptions	9,128.96	
Electrical Engineering nonmembers' subscriptions	44,514.34	
Miscellaneous publications (preprints, Standards, bimonthlies, and other publications)	80,725.64	
Students' fees	26,080.00	
Entrance fees	19,257.55	
Registration fees—Institute meetings and technical conferences	31,269.78	
Membership badges	4,333.65	
Transfer fees	2,840.00	
Interest and dividends on investments of Reserve Capital Fund	35,177.38	
Total income		$1,158,035.39
Expenses:		
Publications expense:		
Electrical Engineering:		
Text	$236,071.34	
Advertising	170,874.68	$406,946.02
Transactions	30,361.93	
"Year Book"	21,130.95	
Bimonthly publications	122,102.64	
Special and technical conference publications	66,001.02	
Institute meetings	42,280.73	
Institute Sections	132,937.89	
Institute Branches	11,352.87	
Section and Branch—Paper prizes, including travel expense	8,509.28	
Finance Committee	1,736.20	
Headquarters Committee	1,574.96	
Membership Committee	26,632.50	
Standards Committee	22,220.49	
Technical committees	21,984.32	
Committee on Public Relations	22,070.62	
Planning and Co-ordination Committee	11,004.62	
Other committees	47.54	
Traveling expenses:		
Geographical Districts:		
Executive Committees	15,928.02	
Vice-Presidents	3,681.45	
Conferences on Student Activities	16,331.99	
Board of Directors	17,055.51	
Nominating Committee	1,868.02	
President's appropriation	1,125.30	
Institute representatives	973.24	
Administrative expenses:		
Salaries	105,807.84	
Stationery and miscellaneous printing	14,252.72	
Postage	8,565.28	
Social security taxes	3,927.85	
Depreciation of furniture and fixtures, $4,855.83, plus other, $526.00	5,381.83	
Legal services	250.00	
Rent, etc.—Editorial office, 500 Fifth Avenue	8,563.24	
Miscellaneous	10,220.75	
Forward	$1,162,827.62	$1,158,035.39
Total Income (forward)		$1,158,035.39
Expenses (forward)	$1,162,827.62	
Retirement system—AIEE—normal contribution (including actuarial fees and other expenses, $225.42)	11,660.56	
Transfer to restricted fund reserve—retired employees' insurance	6,000.00	
Geographical Districts—Branch paper prizes	678.91	
Institute prizes	1,161.00	
American Standards Association	1,500.00	
Canadian Radio Technical Planning Board	10.00	
Engineers' Council for Professional Development	2,995.00	
Engineering Foundation Project—Welding Research	250.00	
Engineers Joint Council	10,270.80	
National Council of State Boards of Engineering Examiners	500.00	
U. S. National Committee—International Commission on Illumination	300.00	
International Electrotechnical Commission	500.00	
Conference of Representatives from the Engineering Societies of Western Europe and the United States of America	552.16	
John Fritz Medal Award	304.12	
Charles LeGeyt Fortescue Fellowship Committee	80.34	
United Engineering Trustees, Inc.:		
Building assessments	25,578.90	
Library assessments	19,276.00	
Library retirement plan	4,758.65	
Membership badges	5,550.90	
Exchange allowances to non-resident members	9,330.58	
Total expenses		1,264,085.54
Excess of Expenses Over Income for the Year (see note)		$ 106,050.15
Operating Fund Reserve:		
Balance, May 1, 1954	$ 12,082.01	
Transfers from:		
Reserve Capital Fund	100,000.00	
Property Fund Reserve—Office furniture and fixtures, less Reserve for Depreciation, $45,910.54, as of May 1, 1954	29,189.09	
Total	$ 141,271.10	
Less write-off of uncollectible dues, less reversal of reserve, $10,000 (see note)	1,714.10	139,557.00
Balance, April 30, 1955		$ 33,506.85

Note: As of January 1, 1955, the Institute discontinued the practice of including dues, subscriptions, etc., in income as accrued, such income thereafter being deferred until collected. As a result, income for the year is less and the excess of expenses over income is greater than such items would otherwise have been by approximately $32,000. The change was made to facilitate comparison of the income statements with the cash budget forecasts.

Exhibit C — Statement of Restricted Fund Reserves for the Year Ended April 30, 1955

	Total	Reserve Capital Fund	Life Membership Fund	Member-for-Life Fund	International Electrical Congress of St. Louis Library Fund	Edison Medal Fund	Lamme Medal Fund	Mailloux Fund	Volta Memorial Fund	Retired Employees' Insurance Fund
Balance, May 1, 1954	$780,064.36	$707,176.76	$6,178.27	$19,015.13	$6,623.59	$ 9,545.84	$9,323.68	$1,033.14	$17,167.95	$ 4,000.00
Additions:										
Transfer from operating fund (Exhibit B)	6,000.00									6,000.00
Income from investments	1,975.82	*	137.50	268.57	137.50	720.00	345.00		367.25	
Interest on bank balances	49.60		23.07					26.53		
Dues paid by members for life	3,156.55			3,156.55						
Profit on sale of securities	61,182.09	61,164.59							17.50	
Total	$852,428.42	$768,341.35	$6,338.84	$22,440.25	$6,761.09	$10,265.84	$9,668.68	$1,059.67	$17,552.70	$10,000.00
Deductions:										
Transfer to operating fund (Exhibit B)	$100,000.00	$100,000.00								
Authorized withdrawal from life membership fund	361.87		$ 361.87							
Purchase of medals, cost of engraving, etc.	628.30					$ 386.85	$ 241.45			
Library purchases	165.05				$ 142.05			$ 23.00		
Traveling expenses—District Branch prize winners	1,741.35			$ 1,741.35						
Scholarship awards	1,175.00								$ 1,175.00	
Cable charges	8.60								8.60	
Total deductions	$104,080.17	$100,000.00	$ 361.87	$ 1,741.35	$ 142.05	$ 386.85	$ 241.45	$ 23.00	$ 1,183.60	
Balance, April 30, 1955 (Exhibit A)	$748,348.25	$668,341.35	$5,976.97	$20,698.90	$6,619.04	$ 9,878.99	$9,427.23	$1,036.67	$16,369.10	$10,000.00

Income from Reserve Capital Fund investments is credited to operating fund (Exhibit B).

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Schedule 1 — **Restricted Funds—Securities Owned, April 30, 1955**

Name of Issuer and Title of Issue	Principal Amount	Book Value
Reserve Capital Fund:		
Bonds:		
Public utility bonds:		
American Telephone & Telegraph Company 2¾% debentures:		
Due 1971	$20,000.00	$ 19,650.00
Due 1975	10,000.00	10,062.50
Philadelphia Electric Company first refunding 2¾%, due 1967	20,000.00	20,412.50
Total public utility bonds		$ 50,125.00
Industrial bonds:		
Dow Chemical Company 3% convertible subordinated debentures, due 1982	$25,000.00	$ 24,656.25
Shell Union Oil Company 2½% debentures, due 1971	20,000.00	19,800.00
Standard Oil Company of Indiana 3¼% convertible debentures, due 1982	25,000.00	24,875.00
Standard Oil Company of New Jersey 2¾% debentures due 1971	20,000.00	19,675.00
Total industrial bonds		$ 89,006.25
Dominion of Canada, externals 3%, due 1963	$10,000.00	$ 10,050.00
United States Government bonds:		
Treasury bonds 2½%, due December 15, 1967–72	$35,000.00	$ 34,814.06
Treasury savings bonds:		
Series G 2½%, due September 1, 1955	40,000.00	40,000.00
Series G 2½%, due November 1, 1956	17,000.00	17,000.00
Series G 2½%, due May 1, 1957	20,000.00	20,000.00
Series G 2½%, due October 1, 1957	30,000.00	30,000.00
Series G 2½%, due May 1, 1961	30,000.00	30,000.00
Series G 2½%, due July 1, 1961	15,000.00	15,000.00
Total United States Government bonds		$186,814.06
Total Bonds		$335,995.31
	Number of Shares	
Capital stocks:		
Preferred stocks:		
Atchison, Topeka & Santa Fe Railway Company	400	$ 19,174.71
General Motors Corporation $5	200	25,820.00
Ohio Edison Company 4.40%	200	21,279.25
Scovill Manufacturing Company 3.65% cumulative	100	10,111.25
United States Steel Corporation 7% cumulative	100	14,885.00
Total preferred stocks		$ 91,270.21
Forward		$427,265.52

Name of Issuer and Title of Issue	Number of Shares	Book Value
Total (forward)		$427,265.52
Common stocks:		
American Gas & Electric Company	600	$ 10,501.07
American Telephone & Telegraph Company	100	17,262.50
Caterpillar Tractor Company	300	13,283.36
Christiana Securities Company	5	34,625.00
Eastman Kodak Company	319 9/100	7,634.71
General Electric Company	650	9,924.77
General Motors Corporation	200	4,235.53
International Paper Company	300	12,536.70
Louisville & Nashville Railroad Company	100	6,278.13
Monsanto Chemical Company	100	9,635.60
Pacific Gas and Electric Company	300	12,652.32
Public Service Company of Indiana	300 and rights	8,547.39
Public Service Electric and Gas Company $1.40 dividend preference common stock	500	14,462.43
Sears, Roebuck and Co.	400	6,014.97
Socony-Vacuum Oil Company	400	8,146.18
Standard Oil Company of New Jersey	400	9,910.35
Standard Oil Company of Ohio	330	15,272.04
Texas Utilities Corporation	300	9,780.29
Union Carbide & Carbon Corporation	300	7,277.42
Westinghouse Electric Corporation	400	18,409.80
Total common stocks		$236,390.56
Total capital stocks		$327,660.77
Total		$663,656.08
	Principal Amount or Number of Shares	
Life Membership Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1975	$ 5,000.00	$ 5,031.25
Member-for-Life Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1971	$ 5,000.00	$ 4,775.00
United States Treasury bonds 2½%, due December 15, 1972/67	5,000.00	4,973.44
Total		$ 9,748.44
International Electrical Congress of St. Louis Library Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1975	$ 5,000.00	$ 5,031.25
Edison Medal Fund:		
General Electric Company common stock	450	$ 9,131.25
Lamme Medal Fund:		
E. I. du Pont de Nemours & Company $4.50 cumulative preferred stock	50	$ 5,952.00
General Motors Corporation $5 preferred stock	24	2,980.44
Total		$ 8,932.44
Volta Memorial Fund:		
U. S. Treasury bonds 2½%, due December 15, 1962/59	$15,000.00	$ 15,450.00
Total		$716,980.71

OF CURRENT INTEREST

Laying of First Transoceanic Telephone Cable Will Span Atlantic From Newfoundland to Scotland

LAYING of the world's first transoceanic telephone cable, to span the Atlantic between Newfoundland and Scotland, began June 22. The transatlantic voiceways are to be extended 300 miles westward from Newfoundland to the eastern tip of Nova Scotia via another submarine cable, and from there to the United States over a 575-mile radio-relay system.

The project is a joint undertaking of American Telephone and Telegraph Company (AT&T), the British Post Office, and Canadian Overseas Telecommunication Corporation, and will cost about $40,000,000. Service will be established late in 1956.

Henry T. Killingsworth, vice-president of AT&T, said the first cable of a twin-cable system would be spun out across 2,000 miles of ocean bottom by summer's end. Summer is the only time the Atlantic is calm enough to permit such an undertaking. Laying operations started at Clarenville, Newfoundland, and will be completed at Oban, which is on the west coast of Scotland about 60 miles from Glasgow. The second cable is to be laid from Scotland to Newfoundland in the summer of 1956.

Mr. Killingsworth, who is in charge of AT&T's long lines department, said the new cable system would greatly improve the telephone service between the United States and Great Britain. This service was inaugurated in 1927 and is handled entirely by radiotelephone.

The transatlantic cables and the Newfoundland–Nova Scotia cable will be laid by HMTS *Monarch* (see cover photograph). The ship loaded the first segment of deep-sea cable at the Simplex Wire and Cable Company plant at Newinton, N. H. After loading, the *Monarch* proceeded to Clarenville and started her historic voyage.

The *Monarch* is owned by the British Post Office and is the world's largest cable-laying ship. Built in 1946, the 8,050-ton vessel is 480 feet long and has a capacity to carry 1,800 nautical miles of deep-sea cable. While laying cable, *Monarch* steams at about 6 knots (i.e., 6 nautical miles of cable per hour will be laid). Cable will be unwound and fed out by electric winches from the drums in the *Monarch's* huge storage tanks and lowered into the water over guiding sheaves. Great care has to be taken to avoid twisting or kinking of the cable as it goes down.

The core of the deep-sea cable to be laid between Newfoundland and Scotland, is a flexible copper tube about 5/8 inch in diameter containing a single concentric conductor surrounded by polyethylene, which completely fills the tube. With the addition of protective coverings of jute and armoring wire, the over-all diameter of the deep-sea cable is about $1^1/_4$ inches. It weighs about 1 pound per foot. In the shallow-water shore ends, where greater protection is required, cable will be more than $2^1/_2$ inches in diameter and will weigh almost 9 pounds per foot. (Only outer covering of cable would be increased in size; core would be same.)

Each of the transatlantic cables will contain 52 intermediate repeaters spaced about 40 miles apart. The deep-sea repeater employs three vacuum tubes and some 60 other electrical components. It is housed in a flexible copper tube about 8 feet long and $1^1/_4$ inches in diameter. This is supported on the inside by steel rings to form a structure that is built into the cable and appears as a tapering bulge. This design permits the repeaters to pass through the cable ship's gear, so that laying will be orderly and uninterrupted.

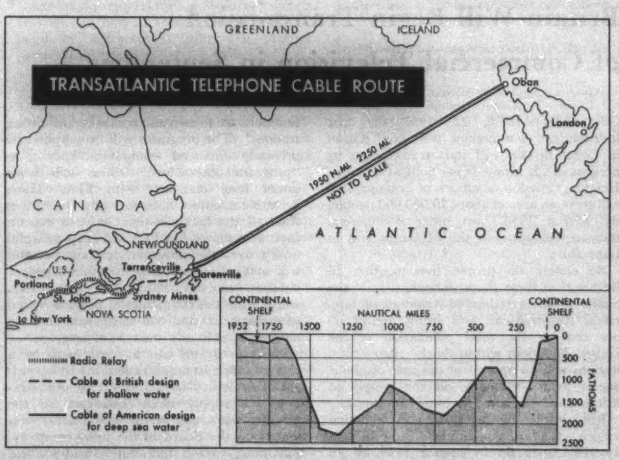
The single cable between Sydney Mines and Clarenville will use amplifiers at 16 intermediate points. Repeaters for this section are of British design and are being manufactured in England. The British repeater is of the rigid type, housed in a forged steel case, 9 feet long and $10^1/_2$ inches in diameter, and weighs about 3/4 of a ton.

Each of the transatlantic cables will be laid in three segments. The shore end, which is more heavily armored than the deep-sea section, is to be payed out between Clarenville and the edge of the continental shelf, a distance of about 200 miles. The second segment, of lighter design, will extend the cable to a point some 500 miles off Scotland. The third will bridge the remaining distance to Oban. Shallow water sections at each end require much heavier armor as protection against the action of the sea and shipping.

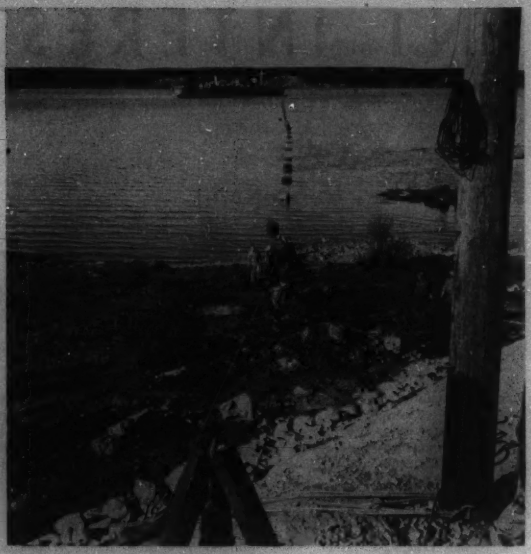
Mr. Killingsworth noted that the radio-relay route will pass within sight of the grave and former home of Alexander Graham Bell, inventor of the telephone. Bell was among the first to believe that this continent could be connected to Europe by voice cable.

Telephone scientists have spent many years developing the amplifiers needed to make a deep-sea voice cable operable. Unique in quality, design, and structure, these amplifiers give weakened voice currents new strength as they speed along their 2,000-mile underwater journey. They were designed to meet three difficult specifications: They had to withstand enormous pressures at the ocean floor, pressures sometimes reaching 3 tons per square inch; they had to be built into the cable and still be slim enough and flexible enough to pass through the ship's laying gear; and they had to operate for many years without attention. Each of the twin transatlantic cables will contain 52 amplifiers spaced about 40 miles apart.

Mr. Killingsworth said each of the trans-



OVER-ALL ROUTE of first transatlantic cable system extends from Portland, Maine, to Oban, Scotland. Inset shows the varying depths of the Atlantic floor.



FIRST SEGMENT of projected transatlantic telephone cable is pulled ashore at Clarenville, Newfoundland, from the cable-laying ship, HMTS Monarch. Empty oil can floats help crewmen maneuver cable through shallow water.

atlantic cables will be equipped to transmit speech in one direction. Thus voices from New York will travel eastward over one cable and voices from London will be carried westward over the second cable. The system will be able to carry 36 conversations at the same time, almost tripling the present radiotelephone capacity between the United States and Great Britain.

Reference

Transatlantic Telephone Cable, M. J. Kelly, Sir Gordon Radley, G. W. Gilman, R. J. Halsey. *Electrical Engineering*, vol. 74, March 1955, pp. 192–7.

Britain Will Begin Transmission of Commercial Television in September

ON SEPTEMBER 22, 1955, the first independent commercial television station in Great Britain will start transmitting its programs. It is now being built at Beaulieu Heights, Croydon, a suburb of London, and will serve an area of about 10,000,000 people. By March 1956, two other commercial stations will open, in the Midlands and in Lancashire.

So closely do people live together in Britain that these three stations, despite the relatively short radius of coverage of television transmissions, will bring almost 60 per cent of the total population of the United Kingdom within reach. After that, stations will be opened at the rate of about one a year. Virtually all the people in Britain can be reached by 14 or 15 stations.

Responsible for Britain's new television service is the Independent Television Authority (ITA), set up in August 1954 by an Act of Parliament. It has a statutory life of 10 years. Under this Act ITA will not have to produce programs. Its main functions are to own and operate transmitting stations. The programs will be supplied by privately financed companies known as "program contractors," which will work under long contracts with ITA. These private companies have to equip themselves with all the facilities they need to put on their own shows, but ITA will keep a careful watch over the programs it transmits and will make sure that they maintain a proper balance, and preserve good taste. ITA will require the companies to provide varied entertainment, and will make sure they do not specialize in any one type of program.

News programs will be dealt with by a private specialist organization, the Independent Television News Ltd. This organization will supply news broadcasts to the private companies, all of which are represented on the Board of the news company. ITA must see to it that all news and political matters broadcast are accurate and impartial.

Only in exceptional circumstances will ITA put on its own programs—if it is necessary in order to secure a proper balance in the programs, or if there happens to be a temporary absence of private companies able to provide material. However, this emergency is not expected to arise frequently.

ITA, for its initial capital expenditure, is to be allowed a loan from the Government of up to £2,000,000 ($5,600,000) within the first 5 years of its life, but only £1,000,000 ($2,800,000) of this loan can be drawn during the first year. The whole amount will have to be repaid before the end of ITA's statutory life in July 1964. The Authority also may be given up to £750,000 ($2,100,000) each year on a special Government grant. For the needs of the moment, however, ITA will have to rely almost entirely upon the money it will receive from the sale of transmission time on its stations to the private companies.

The private program companies will obtain their income from the sale of advertising time in the programs they provide, but advertisers will not be allowed, as they are in the United States, to "sponsor" programs. Once programs have been worked out and created by the companies, they will be offered to advertisers. The complete program will resemble the contents of a newspaper or magazine; there will be editorial contents and advertisements, and advertising time will be purchased.

ITA controls the amount of time allotted to advertising. "Spot" advertising time must not exceed an average of 6 minutes in the hour, although advertising features such as a "shopping guide" are not subject to this limit. Advertisements may be inserted only at the beginning or end of programs, or in natural breaks; that is, not in specially manufactured breaks. Furthermore, there must not be more than six periods of advertising in any one hour. No advertising material is allowed to be inserted into programs dealing with religion, Royalty, or national ceremonies.

At present, the only television service in Britain is conducted by the British Broadcasting Company (BBC). It is a national service and will continue after ITA has started. The BBC may begin a second program when it has been allotted a wavelength, but the BBC does not, and will not in the future, run a commercial television service.

New Wire Insulation Lengthens Motor Life

A major step toward smaller, longer-lived, and more efficient electric equipment has been made by scientists at the Westinghouse Research Laboratories through the development of a new insulating enamel for copper wire.

Laboratory tests on electric motors insulated with the new enamel show that the motors can operate continuously for 10 years at a temperature of 325 F without damage to the insulation. This length of time is equivalent to the normal operation of a refrigerator motor for 30 years, or a washing machine motor for about a century.

This new enamel is a modified polyester-type resin containing about 20-per-cent silicone and represents the culmination of 10

years of research and development of polyester-type wire coatings. By incorporating silicones into these materials, an insulation is produced which can withstand higher temperatures for longer periods of time than any wire enamel which does not contain silicones. Also, raising the limiting temperature of an electric motor to 325 F will mean a reduction in the size of present motors.

Using this new enamel to replace the glass insulation normally required for high-temperature motor windings would reduce the thickness of insulation by 50 per cent.

It was revealed that the new insulating enamel has been used for more than a year in pilot-scale manufacture of Westinghouse motors. It has also seen service in certain transformers and in the coils of high-temperature relays. The enamel has been successfully applied to all sizes of copper wire from gauge 40 (about 0.003 inch in diameter) to gauge 10 (which is over 0.1 inch in diameter).

First Industrial Reactor to Be Installed at Armour

A force "greater than the atomic bomb"—peacetime nuclear energy—was carried a step further in Chicago, Ill., on June 13, as construction began on a building to house the nation's first industrial research reactor.

Ground was broken near 35th and State Streets for a $1,750,000 5-floor research building at Armour Research Foundation of Illinois Institute of Technology.

In addition to the nuclear reactor, the building will house the Foundation's physics and electrical engineering research departments. It will be completed by April 1, 1956.

Approximately 20 industrial concerns will participate in the Foundation's nuclear reactor research program through payments of $20,000. In return, they will share in benefits derived from the research for 3 years.

The reactor is being built by North American Aviation, Inc., at its Downey, Calif., plant under a construction permit issued by the U.S. Atomic Energy Commission. The permit was the first to be issued by the Commission for a private nuclear reactor designed specifically for industrial research.

ASME Issues "Book of Facts" Marking Diamond Jubilee

The American Society of Mechanical Engineers (ASME) has issued a "Diamond Jubilee Book of Facts," in conjunction with the society's 75th anniversary being celebrated throughout 1955. It is designed for use by publications, industrial concerns, advertising agencies, state and local governments, engineering schools, and others wishing to participate in the anniversary celebration.

Contents of the book include a short history of the society; material on the role of mechanical engineers in today's world; a copy of the organizations's first catalogue, printed in the founding year of 1880; and biographical summaries of persons prominent in ASME history.

Certificates of recognition will be awarded to persons and groups taking part in the anniversary celebration. Those wishing further information should write to Public Relations Office, ASME, 29 West 39th Street, New York 18, N.Y.

Perfect Slivers of Iron Developed at Westinghouse

Pure and perfect slivers of iron, having breaking strengths approaching 1,000,000 pounds per square inch—far greater than any other known metal—have been produced on an unprecedented scale by the Westinghouse Research Laboratories. Dr. J. A. Hutcheson, vice-president and director of Westinghouse research, disclosed that the slivers of iron, or "whiskers," are each a pure iron crystal so perfect that no defects can be detected in its structure. The crystals are as much as 2 inches long and 0.001 inch thick. Previous attempts to produce these whiskers have given crystals which could be observed only with the aid of a microscope.

Very little is known about metals that are completely free of impurities and imperfections simply because they are never found in nature and, until recently, could not be prepared in the laboratory.

Theoretically, however, it is known that such metals should exhibit fantastic properties which could make them extremely valuable to man. For example, pure iron has an ultimate tensile strength of more than 1,000,000 pounds per square inch. This is at least ten times the strength of ordinary iron which has been hard drawn into wire and at least three times the strength of the kind of steel used in making piano wire.

"Pure and perfect iron will not emerge tomorrow as a brand new construction material," Dr. Hutcheson said, "but at last it has been prepared on a scale large enough that we can make a realistic study of it and begin to find ways to utilize the unusual properties it possesses."

Preparation of the perfect iron and testing of its mechanical properties was done by Drs. A. W. Cochardt, H. W. Wiedersich, and R. L. Eisner of the Laboratories' metallurgy department. The iron is the result of the perfection of a new whisker-growing technique which was originated in the Laboratories about 2 years ago by Dr. John C. Kelly, physical chemist in the magnetics and solid-state physics department.

The perfect iron whiskers were made in this manner: Highly purified iron chloride, a common "salt" of iron, is heated in an atmosphere of hydrogen gas inside a special furnace at a temperature of about 1,100 F. Through rigid control of the temperature and flow of hydrogen, the chlorine atoms in the iron chloride are allowed to unite chemically with the hydrogen at a certain precise rate. This leaves unattached atoms of iron, which migrate slowly toward each other and deposit one upon another in perfect arrangement. Thus, billions of iron atoms grow without any observable defects into a single perfect crystal of pure iron, exactly square in cross section, and often attaining a length of 2 inches.

Future Meetings of Other Societies

Symposium on Electronics in Automatic Production, jointly sponsored by Stanford Research Institute and the National Industrial Conference Board. August 22–23, 1955, Sheraton-Palace Hotel, San Francisco, Calif.

West Coast Electronic Show and Convention. August 24–26, 1955, Civic Auditorium, San Francisco, Calif.

Machine Tool Show; Production Engineering Show (held concurrently). September 6–17, 1955, International Amphitheatre and Navy Pier, Chicago, Ill.

Instrument Society of America, Conference, "Instrumentation Paces Automation." September 12–16, 1955, Shrine Auditorium, Los Angeles, Calif.

Illuminating Engineering Society, National Technical Conference. September 12–16, 1955, Statler Hotel, Cleveland, Ohio

Association for Computing Machinery, Annual Meeting. September 14–16, 1955, University of Pennsylvania, Philadelphia, Pa.

Institute of Radio Engineers, Second National Annual Meeting of Profesional Group on Nuclear Science. September 14–16, 1955, Oak Ridge, Tenn.

Radio-Electronics-Television Manufacturers Association, Automation Symposium. September 26–27, 1955, Irvine Auditorium, University of Pennsylvania, Philadelphia, Pa. Radio Fall Meeting. October 17–19, 1955, Hotel Syracuse, Syracuse, N. Y.

Atomic Industrial Forum, Trade Fair and Fall Meeting. September 26–30, 1955, Sheraton-Park Hotel, Washington, D. C.

Société Belge des Ingenieurs des Telecommunication et d'Electronique, International Analogy Computation Meeting. September 27–October 1, 1955, Brussels, Belgium

Standards Engineers Society, Fourth Annual Meeting. September 29–October 1, 1955, Hotel Statler, Hartford, Conn.

National Electronics Conference, Inc. October 3–5, 1955, Hotel Sherman, Chicago, Ill.

Canadian Electrical Manufacturers Association, 11th Annual Meeting. October 5–7, 1955, Sheraton-Brock Hotel, Niagara Falls, Ont., Canada

Electrochemical Society, Inc. October 9–13, 1955, William Penn Hotel, Pittsburgh, Pa.

Eastern Electrical Wholesalers Association, Third National Electrical Industries Show. October 11–14, 1955, 69th Regiment Armory, New York, N. Y.

National Safety Council, 43d National Safety Congress and Exposition. October 17–21, 1955, Conrad Hilton, Congress, Morrison, and LaSalle Hotels, Chicago, Ill.

Steel Founders' Society of America, Fall Meeting. October 24–25, 1955, The Greenbrier, White Sulphur Springs, W. Va.

American Standards Association, 37th Annual Meeting in conjunction with 6th National Conference on Standards sponsored jointly by ASA and the National Bureau of Standards. October 24–26, 1955, Sheraton-Park Hotel, Washington, D. C.

Ceramic and Metal Research Aid Manufacturing Processes

Visitors to the Ward Leonard plant in Mount Vernon, N. Y., are usually impressed by the fact that ceramics and metals play a predominant role in the design and fabrication of this company's products. These two basic components receive major attention in an extensive research and production control program. As a result, Ward Leonard has been able to achieve high standards in the characteristics of its resistors, rheostats, and other electric products.

Until July 1953, the company depended on wet chemistry, petrographic microscopy, and other specific analytical methods for obtaining answers to questions pertaining to the raw materials. Since then, X-ray analysis has completely altered the situation. According to Charles J. Ganci, chemical engineer and manager of manufacturing engineering, this new tool has made it possible to catch up with a large backlog of work and has kept the laboratory abreast of the current accelerated flow of such problems.

The laboratories assist in a wide variety of development and production problems, and Norelco X-ray apparatus is used to analyze all ceramic raw materials received at the plant. Many products are assembled on porcelain structures which are extruded through dies prior to firing.

Analysis of incoming ceramic raw materials are of paramount importance since any variations may cause serious trouble. Dies are designed for specific compositions with respect to drying and firing shrinkage and porosity. If these conditions are not maintained, dimensional tolerances will be exceeded and the expensive dies will not produce a satisfactory product.

LABORATORY TECHNICIAN at the Ward Leonard plant examines chart during analysis of a specimen in the Norelco X-ray instrument.

Metals also play an important part. Flat contact arms on ring rheostats are made of SAE *1075* steel and some time ago trouble developed on a certain lot during life tests. The metal cracked and appeared to be excessively brittle. The same thing happened to a batch of phosphor bronze contact fingers used on relays.

X-ray Diffractometer charts were made in each of these instances in order that the faulty metal could be compared with other lots having good performance records. Improper heat treatment was suspected so the laboratory put 15 or 20 specimens of the good metal through different annealing procedures.

The X-ray charts from the treated specimens established a definite clue. As heat-temperatures were raised and stresses in the metals were decreased, chart peaks became proportionately narrower at their bases. In other words, for specimens of the same basic composition, chart peaks with wide bases indicate more stress in the metal. The production lot of brittle contact arms and the batch of faulty contact fingers produced X-ray charts which exhibited this wide-base characteristic.

Another example where X ray helped solve a problem was concerned with core material intended for use in a new magnetic amplifier. For best operating characteristics, it was important to have proper crystal orientation.

Hysteresis losses were excessive in some specimens of the core metal yet chemical tests gave no indication of what was wrong. When the laboratory studied grain size and orientation with the aid of a flat-plate X-ray camera the difference in core specimens was revealed. The supplier was then required to furnish the desired grain orientation.

Crystal structure of wire used for winding resistors is also important. Since electrical resistance directly relates to the degree of contact between crystal faces, it becomes vitally important to keep this factor under proper control. X ray is helping the laboratories on this task.

In general, X-ray techniques have made it possible to establish an entirely new set of standards for metal composition and annealing processes. Purchased supplies now must meet these requirements and as a result final product quality has reached new high levels.

An interesting sidelight is the fact that Ward Leonard extends a helping hand to the Police and Fire Department in Mount Vernon whenever possible. In one or two cases of suspected arson in the local community, X ray was used to analyze residue that remained in the burned building.

New Engineering Career Film Topic at Eta Kappa Nu Meeting

A meeting of the Delta Chapter (Illinois Institute of Technology) and the Chicago, Ill., Alumni Chapter of Eta Kappa Nu Association, electrical engineering honor society, was held in Chicago, May 13. Initiation of new undergraduate and professional members into the association included AIEE member Harry P. St. Clair (F'44).

Main event of the evening was a talk given by Dr. W. L. Everitt (F'36), dean of engineering, University of Illinois, and chairman of Eta Kappa Nu's Movie Committee. He talked about a new sound movie in color, "Engineering, a Career for Tomorrow." This film has been a joint project of the association and the University of Illinois (Urbana). The film developed from plans made in 1953 for an anniversary project celebrating the semicentennial of Eta Kappa Nu. Film production took about $1\frac{1}{2}$ years and was made possible by a basic contribution from the treasury of the association, the co-operation of the Chicago Alumni, and the guidance of R. D. Borgstadt (M'48) and J. E. Farley. Enough money was collected from individual members and from industry to underwrite the out-of-pocket expenses of the Motion Picture Television Unit of the University of Illinois, producer of the film.

TAKING PART in the meeting of the Delta Chapter and the Chicago, Ill., Alumni Chapter of the Eta Kappa Nu Association May 13 were (left to right): W. L. Everitt (F'36), dean of engineering, University of Illinois; H. P. St. Clair (F'44), manager, planning and operating engineering, American Gas and Electric Service Corporation; and E. T. B. Gross (F'48), past national president of Eta Kappa Nu.

Dr. Everitt said the movie was planned to indicate what engineering really is, and what qualifications are needed to be a good engineer. Although reference is made to electrical engineering in typical examples of engineering work, the movie serves the interests of all engineering branches.

Inquiries concerning this film should be sent to the headquarters of the Eta Kappa Nu Association at P. O. Box 447, Dillsburg, Pa.

Electronic System Spots Fire in Aircraft Engines

A new electronic system, the Fireye Visual Fire Detector, that detects an aircraft engine fire with the speed of light, is being installed on the Hercules *C-130A*, the Air Force's first turbo-prop combat transport plane.

In the airplane whose engines are to be protected, the detecting elements (detectors), often as few as one or two, are set up in each compartmented zone of each engine. As many as nine detectors can be used in a single detection system. However, it is seldom that this many are needed.

The control unit that interprets the signal from the detectors can be located anywhere in the airplane outside the airplane engine.

When the detection system indicates a fire, the control unit flashes a warning light in the cockpit which advises the crew that a fire has started in a particular engine.

The heart of the new Fireye system is a miniature, rugged photoconductive cell,

developed by Electronics Corporation of America engineers for the purpose of fire detection. Infrared sensitive, the photoconductor is ideally suited for spotting fires because infrared is emitted in considerably larger quantities by fires than by any other wavelength of radiation.

The photoconductive cell indicates accurately, by very rapid resistance changes, the varying amounts of radiation emitted by a flame: specifically it detects the flicker which distinguishes flames from constant infrared radiation such as lamps, heat processes, etc. The radiation from the flame causes a pulsating signal to be transmitted to the control panel which, being frequency-sensitive to this signal, actuates the fire warning system. An optical filter (cover over the cell) passes only infrared radiation.

The detector does not have to "see" the flame directly in order to set off the alarm. Because most materials readily reflect infrared, the Fireye system can detect a fire from both reflected and direct radiation, as well as from radiation transmitted through glass and other transparent materials.

Impedance Switch Enables Control of Lamps by Touch

The new General Electric Touchtron control is an electronic impedance switch, by which on and off switching action of a lamp is controlled by a touch of the hand of two closely adjacent metal surfaces. No movement of the metal parts is involved as with a mechanical switch, and no pressure is required. Furthermore, the touch area is not restricted in size and in location as is the case with the usual mechanical switch. In a table lamp for example, the metal base of the lamp may be one touch area, while a decorative band or filagree, or even the vase, if made of metal, can be the second touch area. Thus touch control can be achieved from any angle.

Touching the two designated areas causes a special electronic tube of General Electric design to fire. The triggering of this tube operates a new type of relay, also of special design, to turn the lamp on, then off, then on, etc., with each touch.

TOUCHTRON, new electronic lamp control, enables a lamp to be lighted by touching it.

The Touchtron control unit has been designed so that it draws negligible power from the line. Special circuits were incorporated to provide trouble-free operation for years for the wide voltage range encountered in the American home, and to minimize the effects of external interference, such as those which sometimes spoil the picture quality on a television screen. Special emphasis was given to providing a control which is safe to use. The control is 25 times as safe as the Underwriters' Laboratories require.

TV Cameras Aid Rangers In Detecting Forest Fires

"Electronic fire watchers," mounted on lookout towers deep in the forests, now relay television pictures of the surrounding areas back to forest headquarters where the rangers can spot fires as soon as they start, helping to prevent the huge, costly holocausts that annually destroy $60,000,000 worth of timber. The device was demonstrated recently by Raytheon Manufacturing Company, Waltham, Mass.

The equipment works without the use of wires or cables. A microwave beam carries the picture from the television camera in each lookout tower, across miles of rugged terrain to the forest headquarters. There, a series of television monitors shows the observers the scenes picked up by the cameras. The cameras rotate continuously, but may be stopped, started, or reversed by remote control—again through the use of a microwave beam.

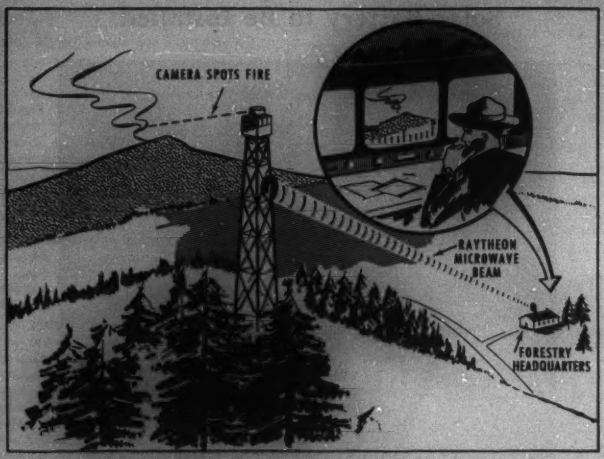
As each camera rotates, it records not only the forest scenery, but an azimuth scale on the glass dome. Thus, if a forest fire is spotted, the camera may be stopped with its lens trained on the fire and the bearing may be noted. When bearings are obtained from two or more towers, the location of the fire may be pinpointed on a map by the simple process of triangulation.

Since the advent of television, forestry officials have predicted that the television camera would eventually become a powerful ally of the forest ranger, giving him an "all-seeing eye" to help keep watch over vast areas of wilderness. The limiting factor, however, has been the expense and impracticability of stringing miles and miles of costly coaxial cable from the lookout towers to headquarters. Such cables would be subject to falling trees or branches, high winds, ice storms, and forest fires themselves. The microwave link eliminates the need for wires.

The link is a specialized version of a device originally designed for the television industry.

Solar Battery to Be Installed

SOLAR BATTERY developed by the Bell Telephone Laboratories as announced last spring (EE, June '54, pp 577–8), will receive its first practical test as part of the telephone system this summer when an experimental unit—essentially identical to the model shown here mounted on a section of telephone pole—will be installed in Americus, Ga., to supply power to terminal equipment on rural telephone lines. The heart of the battery is the specially prepared silicon disk which converts sunlight into electricity, making this the first successful device to do so directly and efficiently. The model contains 432 disks. During daylight, the battery powers equipment directly and charges a storage battery to provide power for nighttime or periods of lowered sun intensity. The solar battery can be tilted for maximum exposure.



NEWEST WEAPON to fight the annual loss from forest fires is this electronic fire-watch system which employs a rotating television camera to spot a fire and beams the picture, via microwave, to headquarters. Two or more unattended towers can obtain cross-bearings and pinpoint the blaze.

It consists of suitcase-sized units which are easily and quickly attached to the television camera in the field, allowing the camera crew to photograph such events as ball games, news events in the streets, and other on-the-spot scenes. A lightweight aluminum parabolic reflector is mounted on a tripod, preferably on the roof of a near-by building, and is connected to the camera and unit in the street below. The link picks up both the sound and picture, and feeds both to the "dish," which beams them out on one waveband, simultaneously, to the receiving unit which may be located as far as 25 miles away. There, the sound and picture are separated electronically, and may be fed through a regular studio to the local broadcasting tower.

The entire microwave equipment is small and light enough for one man to carry, yet despite its portability, it can be used for permanent installations such as in the fire lookout tower. Under the most severe conditions of use, it has proved itself capable of operating unattended through summer heat and subzero cold with a minimum of maintenance. The pictures that it relays are clear, steady, and highly detailed; enough so that forestry men expect it to help catch poachers, firebugs, and other lawbreakers occasionally. The pictures are unaffected by atmospheric conditions or other common forms of interference.

NBS Constructs Portable Secondary Frequency Standard

A compact high-stability 1-mc frequency standard, constant to a few parts in 10 billion per day, has been designed and constructed at the National Bureau of Standards (NBS). The standard employs an oscillator and a 1-mc AT-cut quartz crystal unit in a bridge-balancing frequency-correction system. Developed by Peter G. Sulzer of NBS, the standard produces a frequency which is almost entirely independent of tube, component, and supply-voltage changes. Because of its convenient size and its use of relatively inexpensive, commercially available components, this secondary standard should prove to be a valuable tool both in the laboratory and in the electronics and communications industries.

A widespread need exists for highly accurate secondary standards of frequency and time. Such standards are used for checking radio transmitters, making astronomical measurements, calibrating precision clocks, and a variety of other scientific measurements. In an effort to provide such standards, NBS is conducting a research program aimed at improving the characteristics of crystal-controlled oscillators.

Experiments have shown that the characteristics of a crystal unit can be measured precisely in a resonance bridge. If an oscillator is adjusted to resonance with a highly stable crystal unit, the resonant frequency of the unit can be measured with a resolution of 1×10^{-10} or better. Such a system constitutes a useful frequency standard, particularly if continuous frequency adjustment is made by automatic means.

In the system developed at NBS, the crystal unit is connected in a low-impedance bridge. The bridge is driven by an oscillator whose frequency is variable over a small range. If the frequency of the oscillator differs from that of the crystal, the bridge produces an output voltage which is amplified by a null detector and rectified by a phase detector. The output of the phase detector is then used to actuate a control which decreases the frequency error. This form of control has been used by others.[1]

Two arms of the bridge consist essentially of a crystal unit (which may be called X) connected in series with a resistance R which is equal to the series-resonant resistance of X. These two circuit elements together with an amplifier also constitute a simple oscillator which oscillates near the series-resonant frequency of X. The bridge is completed by the addition of two equal resistances of a somewhat higher value than R. Since the crystal unit is common to the bridge and the controlled oscillator, some simplification of the circuitry is realized.

In operation a small capacitor C is switched alternately across one or the other of the equal bridge arms by means of a chopper. The bridge output is fed into the null amplifier, which has a voltage gain of approximately 10^9, and is rectified by another tube. Two other capacitors are charged alternately in synchronism with the switching of C by means of a second chopper. The difference in the voltages across these two capacitors is used to actuate a reactance tube which varies the frequency of the oscillator over a small range.

If there is no frequency difference between the oscillator and the crystal unit, equal bridge outputs are obtained for the two switched positions of C. When this happens, equal voltages are placed across the two capacitors, and the reactance tube is not actuated. If a frequency error does occur, however, different bridge outputs are obtained for the two positions of C, and frequency correction takes place.

To realize the utmost in frequency stability, the crystal unit must be operated at a constant balance-temperature. In the NBS oscillator a temperature-sensitive bridge, which is wound on the walls of the crystal-unit container, is supplied with a small amount of line-frequency power. If the bridge temperature differs from its balance temperature, an alternating output voltage at the line frequency is obtained. The output is amplified and applied to a phase-sensitive detector, which produces a direct voltage proportional to the bridge-unbalanced voltage. The direct voltage is applied to the bridge, and the resulting heating power tends to drive the bridge to a balance.

REFERENCE

1. Quartz Resonator Servo, a New Frequency Standard, **Norman Lea**. *The Marconi Review*, Chelmsford, England, vol. 17, no. 114, 1954.

ASME Holds Semiannual Meeting in Boston, Mass.

Detlev W. Bronk, president of the National Academy of Sciences, called on American engineers to "increase the scope and power of the human body" by creating "machines for man, to be used as man desires." Dr. Bronk addressed an audience of 400 at the Hotel Statler, Boston, Mass., during the semiannual meeting of The American Society of Mechanical Engineers (ASME) June 21.

"The blast of the first two atomic bombs," he said, "awakened man to an awareness of the human implications of the forces released by man." He praised engineers for their instruments that "enable the greater understanding of man, not only as a living machine, but as a machine with spiritual quality." Among such instruments he listed the microscope, the Roentgen-ray machine, and elec-

tronic amplifiers for the study of the brain and nervous system.

Dr. Bronk is also president of the Rockefeller Institute for Medical Research. He has held the presidency of Johns Hopkins University and the American Association for the Advancement of Science, and the chairmanship of the National Research Council.

The speaker was introduced by toastmaster Frederick S. Blackall, Jr., past president of ASME and president of The Taft-Peirce Manufacturing Company, Woonsocket, R. I. Mr. Blackall paid tribute to Boston's financial community, "which is enthusiastically seeking new fields of investment in corporations whose activities are based on scientific research and development."

"Those who believe that the Yankee will not take a chance do not know their New England," he said, "and those who dismiss the area as economically moribund are blind to the enormous changes which have taken place in New England's industrial economy."

During the banquet it was announced that Joseph W. Barker, chairman and president of the Research Corporation, New York, N. Y., had been nominated to serve as next president of ASME. Mr. Barker will take office in November at the annual meeting, to be held in Chicago, Ill., after letter-ballot approval by the society's 40,000 members.

New Electronic Device Reads Travelers Checks

The prototype of a new electronic device which "reads" travelers checks at the rate of 7,200 an hour and automatically punches the information into punch cards was demonstrated recently at The First National City Bank of New York by Burroughs Corporation.

The new machine is designed to automatize final processing of the many million National City Bank travelers checks which are returned for payment annually from all over the world. It is described as the first workable bank equipment to "read" directly from a source document without the need of human intervention or an intermediate coding operation.

It is said that test results have been gratifying. The machine does the work more than eight times faster than previous methods permitted. At the same time, it has reduced the traditional error factor of 1 per cent in key punching to considerably less than 1/10 of 1 per cent.

The equipment consists of a cable-connected reader and punch, each unit approximately the size of an office desk. By means of electronics and a special photoelectric process, the machine scans the printed numbers of every travelers check which identify its denomination and serial number, and automatically punches a card to correspond. The only action required by the operator is the loading of the machine feeds with travelers checks and blank tabulating card stock, and the removal of machine output.

The "output" cards are then used to operate other equipment which carries out the necessary accounting and record-keeping operations.

Underwater Device Measures Speed of Sound Automatically

The National Bureau of Standards (NBS) has developed an instrument that automatically measures the speed of sound in the sea to depths as great as 300 feet and plots the result as a function of depth or time. The instrument was designed and constructed in the Bureau's sound laboratory by M. Greenspan and C. E. Tschiegg under the sponsorship of the Office of Naval Research. Because of its high accuracy and almost instantaneous response, the velocimeter is expected to be a useful addition to underwater signaling and detecting apparatus. It should also prove to be a valuable research instrument in oceanography.

The speed of sound in large natural bodies of water varies from about 4,600 to 5,140 feet per second. These variations occur with changes in temperature and, to a lesser extent, with changes in the salinity of the water. Sound velocity also increases about 1 foot per second for each 55-foot increase in depth. Several other factors, not all of which are well understood, influence the velocity of sound in the sea.

The sound velocity gradients due to these variables produce curvatures in the rays of sound being propagated in the sea. In some instances, reflections are produced if, as is often the case, the thermal or salinity gradients are abrupt. In current practice an estimate of the sound velocity is calculated from the measured temperature and an assumed salinity. The NBS velocimeter, on the other hand, gives an almost instantaneous meter reading of the actual sound velocity.

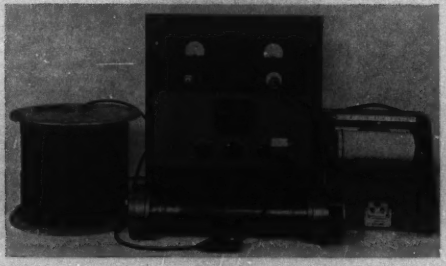
The NBS velocimeter consists essentially of a pair of piezoelectric transducers of polarized barium-calcium-lead titanate and a reflector, mounted to form a sound path of fixed length. The sending transducer is connected to a pulse generator, and the receiving transducer provides the input for a high-gain pulse-shaping amplifier. The amplifier output retriggers the pulse generator, which then applies another pulse to the sender. The sender in turn produces in the water a sound pulse to actuate the receiver. Thus the system continually regenerates a sound pulse whose repetition rate, or frequency, depends on the time it takes the pulse to move through the water. Since the path length is fixed, the frequency depends only on the speed of sound through the water and on the circuit delays. Any variations in sound velocity are recorded as variations in the operating frequency of the velocimeter.

The electric pulse applied to the sender has a very short rise time, and its leading edge is a precise reference point for the location of the pulse in time. On the other hand, the received pulse is much distorted and rises relatively slowly because of selective attenuation by the water. The high-frequency components of the pulse, which control the rise rate, are attenuated to a greater extent than are the low-frequency components. The fast rise is restored by amplification; nevertheless, there is introduced an unknown delay equal to the time which the received pulse spends below the noise level. This delay, which adds to the various circuit delays, depends on the attenuation of the liquid. For this reason, the velocimeter must be calibrated and used on the same or similar liquids. Since the attenuation characteristics of sea water are almost independent of salinity, the instrument may be calibrated in pure water for which the speed of sound is accurately known as a function of temperature.

The maximum rate of pulse rise at the receiver is obtained with a straight path terminated by parallel transducers. How-

ELECTRONIC character recognition equipment includes reader device (left) which "reads" the printed numbers on travelers checks at the rate of 7,200 an hour and transfers the information to punch cards. Card-punching unit is shown on the right.

VELOCIMETER automatically measures the speed of sound in the ocean. Brass "fish" (foreground) contains a pair of piezoelectric transducers and a sound reflector. As the fish is lowered into the sea on a cable, the recorder (right) plots sound velocity vs. depth. Cable supplies power.



ever, under these conditions a system of multiple echoes exists in the water unless the path is inconveniently long. All echoes arising from a single primary pulse are self-synchronous; however, because of the circuit delays, they are not synchronous with those arising from any other primary pulse. These multiple echoes interfere with the proper operation of the instrument.

To eliminate this effect, the pulse path is folded back on itself by means of a plane reflector which absorbs part of the energy of the pulse. Hard rubber and certain plastics are suitable materials for the reflector in the case of a 10-cm path. The use of the 2-way path minimizes errors which arise from the mass motion of the water and also makes possible a more compact device.

In recent performance tests, the NBS velocimeter has been used successfully to plot water temperature and salinity against depth in Chesapeake Bay. The velocimeter can also be used as an underwater control device in other ocean studies.

NEW BOOKS • • • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

A PROFESSIONAL LOOK AT THE ENGINEER IN INDUSTRY. National Society of Professional Engineers, 1121 15th Street, N.W., Washington 5, D.C., 1955. 124 pages, 9 by 6 inches, paper. $3.00 (members $1.50). The purpose of this study is to examine the methods by which the interests of engineers working as employees can be defined, recognized, and treated. The legal background—the Wagner and Taft-Hartley Acts—is discussed in relation to engineering organization, the causes of dissatisfaction are analyzed, and the issue of professionalism versus unionism is examined. Recommendations for a program of action include the improvement of professional status, improvement in employment conditions, and improvement in economic position.

ASTM STANDARDS ON RUBBER PRODUCTS. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1954. 669 pages, 9 by 6 inches, paper. $5.50 (members $4.25). Specifications and standard, tentative, and proposed methods of tests pertaining to rubber and rubber-like products are included in this compilation. Specifications are given for packing and gasket materials, electric protective equipment, insulated wire and cable, etc. Processibility, physical and chemical, low-temperature, and electrical test methods are among those included.

AMPLITUDE-FREQUENCY CHARACTERISTICS OF LADDER NETWORKS. By E. Green. Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex, England, 1954. 156 pages, 10 by 7½ inches, bound. 25s. The first part is a discussion of general properties and response characteristics of low-pass ladder networks, with a section on applications to broad-band networks. Part two deals with applications of these networks in coupling between tubes and resistive load; broad-band matching of reactive loads; low-pass and band-pass filters; and design of networks to obtain optimum performance of tubes. As an aid to design engineers, elementary methods are used to obtain basic equations, and the steps by which general solutions were found are presented.

AUXILIARY PAPER MILL EQUIPMENT. (Pulp and Paper Manufacture, volume 4). J. Newell Stephenson, editor-in-chief. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1955. 732 pages, 9¼ by 6 inches, bound. $9.00. This concluding volume of the series covers instrumentation and process control; pumps and agitating equipment; materials handling; heating and ventilating; steam generation and distribution, water; electric equipment; and bearings and lubrication. Principles, methods, and applications of the topics discussed are presented in terms of practical use in pulp and paper mills.

BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS, 1952 AND 1953 SUPPLEMENT. (Special Technical Publication, No. 56-H). American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1954. 75 pages, 9 by 6 inches, paper. $1.00. A numbered list of over 400 references, grouped by year and accompanied by author and subject indexes. Covering articles published from 1951 to 1953, the supplement brings up to date the comprehensive bibliography of the same title issued as Special Publication 56-G in 1952.

BIBLIOGRAPHY ON INDUSTRIAL RADIOLOGY, 1952–1954. (Fifth Supplement to "Industrial Radiology") By Herbert R. Isenburger. St. John X-Ray Laboratory, Califon, N.J., 1955. 24 pages, 11½ by 9 inches, paper. $3.00. A chronological listing of nearly 700 references to periodical articles, documents, books, and patents. Foreign articles are included, with titles given in English.

ELECTROLYTE SOLUTIONS. By R. A. Robinson and R. H. Stokes. Academic Press, Inc., 125 East 23rd Street, New York 10, N.Y., 1955. 512 pages, 8¾ by 5½ inches, bound. $9.50. The main topics treated are conductance, chemical potential, and diffusion. These properties are considered in detail from the standpoint of the practical electrochemist and with reference to the most recent experimental results. In particular, diffusion is accorded considerable space because of the lack of extended discussion in other books in the field and because of its interest as a link between conductance and free energy studies. Although aqueous solutions are dealt with mainly, some data on nonaqueous solutions are included.

ELECTRONS, ATOMS, METALS AND ALLOYS. By William Hume-Rothery. Philosophical Library, 15 East 40th Street, New York 16, N.Y., revised edition, 1955. 387 pages, 8½ by 5½ inches, bound. $10.00. Written in the form of a dialogue between an older metallurgist and a young scientist, this introduction to the electron theory of the structure of metals and alloys is intended for the metallurgist in industry. The four parts of the book cover the nature of an atom, the nature of a metal, the nature of an alloy, and the structure of the nucleus. In this edition some textural corrections have been made and a few sections have been rewritten where new work has made the old descriptions incorrect.

ELEMENTS OF SERVOMECHANISM THEORY. By George J. Thaler. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N.Y., 1955. 282 pages, 9¼ by 6½ inches, bound. $7.50. This text for senior students presents basic theory without using operational calculus or complex-variable theory, emphasizes frequency-response methods, and integrates and compares the polar and logarithmic approaches to analysis and design. The chief topics treated are transient analysis; transfer functions and transfer function plots; analysis of single-loop systems; gain adjustment; series compensation; and feedback compensation. The two final chapters introduce such advanced topics as root locus methods and phase plane techniques.

HANDBOOK OF TEXTILE FIBERS. Edited by Milton Harris. Harris Research Laboratories, Inc., 1246 Taylor Street, N.W., Washington 11, D.C., 1954. 356 pages, 11¼ by 8½ inches, bound. $12.50. Information and tables of data on both natural and man-made fibers provide extensive coverage of physical and chemical properties of a wide range of fibers, fiber types and sources, constitution and structure of fibers, effect of biological agents, fiber identification, and yarn numbering and count systems. Also given are economic and production data, a glossary, a list of textile periodicals, and tables of chemical and engineering data.

NOISE-REDUCTION MANUAL. By P. H. Geiger. University of Michigan, Engineering Research Institute, Ann Arbor, Mich., 1955. 167 pages, 9½ by 6 inches, bound. $4.00. This is a practical manual dealing with the principles involved in noise problems and with various approaches to their solution. In the opening chapter, procedures for reducing sound waves generated by machinery are discussed in general terms. Later chapters consider in more detail specific applications of sound absorption and insulation, vibration damping, and vibration isolation. Units, instruments, and techniques for measuring noise are also treated.

NOMOGRAPHY AND EMPIRICAL EQUATIONS. By Dale S. Davis. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N.Y., 1955. 236 pages, 9½ by 6 inches, bound. $6.75. The objectives of this textbook for engineering students are to give an easily understandable treatment of the correlation of two- and three-variable data, and to provide minimum but adequate theory, working directions, and practical illustrations for the design and construction of elementary alignment and line co-ordinate charts. Practical drafting hints for nomographers are supplied, and numerous problems drawn from plant experience are included.

NUMERICAL METHODS. By Andrew D. Booth. Academic Press, Inc., 125 East 23rd Street, New York 10, N.Y., 1955. 195 pages, 8½ by 5½ inches, bound. $6.00. A discussion of the mathematical principles underlying the art of programming for an automatic digital calculator. The volume covers interpolation; numerical differentiation and integration; summation of series; ordinary differential equations; simultaneous linear equations; partial differential equations; nonlinear algebraic equations; approximating functions; Fourier synthesis and analysis, and integral equations.

SERVOMECHANISMS AND REGULATING SYSTEM DESIGN. Volume II. By Harold Chestnut and Robert W. Mayer. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1955. 384 pages, 9¼ by 6 inches, bound. $8.50. The first volume, published in 1951, dealt with basic mathematics, physical problems, and design solutions in a manner suited to the needs of students and engineers without previous training in closed-loop control. The present volume, a more advanced treatment intended for practical designers and graduate students, covers measurement techniques; specifications; methods of selecting power and stabilizing elements; all a-c servomechanism design; and nonlinearities in control system design. Illustrative problems adapted from actual design projects are included.

TABLES NUMÉRIQUES DE PHYSIQUE NUCLÉAIRE. (Numerical Tables of Nuclear Physics). By Charles Noël Martin. Gauthier-Villars, Paris, France, 1954. 258 pages, 9½ by 6 inches, paper. Frs. 1800.00. An extensive presentation of numerical data relating to the major energy phenomena occurring in atomic nuclei. The 14 tables are in two groups: six tables based on the semiempirical formula for calculating the masses of the atoms; and eight tables of values for calculating various nuclear reactions. Each table is preceded by an explanatory section.

THE TESTING AND INSPECTION OF ENGINEERING MATERIALS. By Harmer E. Davis, George Earl Troxell, and Clement T. Wiskocil. McGraw-Hill Book Company, 330 West 42nd Street, New York 36, N.Y., second edition, 1955. 431 pages, 9½ by 6½ inches, bound. $6.50. The first section of this book, a general treatment of principles with special reference to mechanical properties of materials, covers measurement of load, length, and deformation, inspection, and the following tests: static tension and compression; shear and banding; hardness and impact; fatigue and creep of metals; and nondestructive testing. The second section describes methods of conducting tests using the most ordinary apparatus. Among the new subjects treated in this edition are ultrasonic testing, low-temperature impact tests, and developments in testing equipment.

THEORY AND DESIGN OF ELECTRONIC BEAMS. By J. R. Pierce. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N.Y., second edition, 1954. 222 pages, 9½ by 6½ inches, bound. $4.75. A presentation for design engineers and advanced students of the minimum amount of material necessary for an understanding of electron flow and electron focusing in devices other than electron microscopes and image tubes. The book covers basic principles and equations; magnetic lenses; thermal velocities; space charge; and design of electron guns. One chapter, new in this edition, deals with periodic focusing fields and the advantages of such fields in reducing magnet weight.

THERMODYNAMICS REFRESHER FOR PROFESSIONAL ENGINEERS LICENSE. By John D. Constance, 625 Hudson Terrace, Cliffside Park, N.J., second edition, 1955. Various paging, 8½ by 11 inches, paper. $3.25. Changes made in this edition consist chiefly of additional problems on processes of gases, internal combustion engines, and a few other topics; a new problem section on reheat and regenerative cycles; a chart to determine specific volume of steam, given pressure, and enthalpy; and minor revisions and corrections in the text. The problems have been selected from examinations given in several states.

ABSTRACTS OF THE LITERATURE ON SEMICONDUCTING AND LUMINESCENT MATERIALS AND THEIR APPLICATIONS. Com-

piled by Battelle Memorial Institute. Sponsored by Electrochemical Society, Inc. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1953 issue, 1955. 169 pages, 11¼ by 9 inches, paper, $5.00. The 775 references from more than 50 periodicals are listed by materials: the solids, including germanium, tellurium, etc.; inorganic compounds such as oxides, selenides, and others; and some inorganic materials. Where articles are numerous, subheadings—properties, purification, uses, etc.—are used, and references on luminescence, phosphorescence, and semiconductor theory are listed separately, as are review articles and books. Many references, particularly those in foreign languages, are without abstracts. Subject and author indexes are included.

ADVANCED MATHEMATICS FOR ENGINEERS. By H. W. Reddick and F. H. Miller. Third edition prepared by F. H. Miller. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1955. 548 pages, 8¼ by 5¼ inches, bound. $6.50. This book is intended for the reader with a thorough training in engineering mathematics through calculus. Beginning with ordinary differential equations, the book takes up in order: hyperbolic functions; elliptic integrals; infinite series; Fourier series; gamma, Bessel, and Legendre functions; partial derivatives and partial differential equations; vector analysis; probability; functions of a complex variable; and operational calculus. Problems relating to electrical, civil, chemical, and mechanical engineering are given with each principal topic.

APPLIED X-RAYS. By George L. Clark. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N.Y., fourth edition, 1955. 843 pages, 9½ by 6¼ inches, bound. $12.50. A comprehensive study of X rays as a practical research tool in industry, thoroughly revised to include the many advances since publication of the previous edition in 1940. The material is presented in two sections, the first covering general physics and applications; the second, analysis of the ultimate structures of materials. New developments in X-ray optics and microscopy are discussed, and special attention is given to chemical analysis by fluorescence.

ENGINEERING ECONOMICS AND PRACTICE. By Max J. Steinberg and William Glendinning. Available from W. Glendinning, 5123 Bell Boulevard, Bayside, N. Y., fourth edition, 1955. 114 pages, 11 by 8½ inches, paper. $3.00. This is a summary of accepted theory and practice designed as an aid to engineers preparing for professional examinations and as a convenient reference manual for practicing engineers. Topics dealt with include compound interest formulas; depreciation; comparison of alternate proposals; calculating a prospective rate of return; replacements; and costs. Text material is supplemented by questions and solutions to problems taken from Part III of the New York State examinations.

FUNDAMENTALS OF ELECTRICAL ENGINEERING. By Ralph A. Galbraith and David W. Spence. Ronald Press Company, 15 East 26th Street, New York 10, N.Y., 1955. 425 pages, 9¼ by 6 inches, bound. $6.00. Emphasizing the scientific foundations of the topics presented, this text for a first course covers the electron theory of matter; circuit elements; electric-energy sources; d-c circuit action; conductors; static and quasistatic magnetic fields and circuits; inductance and coupled circuit action; and static and quasistatic electric fields and capacitance. A special feature is a comparatively lengthy introductory chapter summarizing electrodynamic principles both as a review of the subject and preview of the material to be covered later.

HIGHER TRANSCENDENTAL FUNCTIONS. Volume III. Compiled by the staff of the Bateman Manuscript Project at the California Institute of Technology. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N.Y., 1955. 292 pages, 9¼ by 6½ inches, bound. $6.50. This third and final volume contains chapters on automorphic functions, Lamé and Mathieu functions, spheroidal and ellipsoidal wave functions, functions occurring in number theory, and generating functions. Treatment varies from a detailed account of some functions to brief descriptive accounts of the properties of others, with many references to the literature in the field.

INTERIOR ELECTRICAL WIRING AND ESTIMATING. Part two: Industrial. By Kennard C. Graham. American Technical Society, 848 58th Street, Chicago 47, Ill., 1955. 324 pages, 8½ by 5½ inches, bound. $4.95. This is a practical book which considers specific installation problems in connection with the relevant provisions of the National Electric Code. It covers general methods and equipment; planning and installation of lighting; wiring for motors; generators, power feeders, and services; and transformers, capacitors, and power distribution. In addition, such special circuits and applications as welders, electric signs, X rays, etc., are discussed, and a complete electrical estimate is presented in the last chapter.

MATHEMATICS OF ENGINEERING SYSTEMS. By Derek P. Lawden. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1954. 380 pages, 8½ by 5½ inches, bound. $5.75. An account of a number of methods for the analysis of the behavior of such systems as electronic amplifiers and oscillators, electric circuits, servomechanisms, and regulators. Separate chapters are devoted to Fourier analysis, nonlinear differential equations, and to classical and modern methods of solving linear differential equations with constant coefficients. Although the emphasis is on the mathematical methods described, applications to practical problems are included.

MECHANICAL AND ELECTRICAL EQUIPMENT FOR BUILDINGS. By Charles Merrick Gay, Charles De van Fawcett, and William J. McGuinness. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., third edition, 1955. 564 pages, 8½ by 5½ inches, bound. $8.50. Similar in arrangement to the previous edition published in 1945, this book covers design, specifications, installation, operation, and maintenance of building equipment under the following headings: water supply; sanitation; heating; air conditioning; electric equipment; and acoustics. This edition has been extensively revised to include new data on pumps, baseboard heating, radiant heating, and other subjects, and to bring the text into conformity with modern practice and the latest pertinent codes and standards.

THE RADIO AMATEUR'S HANDBOOK. 32d edition—1955. American Radio Relay League, West Hartford, Conn. Various paging, 9½ by 6½ inches, paper. $3. A standard reference manual covering the entire field from basic theory to practical constructional details, and including comprehensive and up-to-date vacuum-tube data tables. This edition, revised in the light of recent developments, contains new information on vhf radio transmitters and a considerable amount of new tube data. A large catalogue section features the equipment of leading manufacturers.

RADIOISOTOPE CONFERENCE, 1954. Proceedings of the Second Conference. Volume II: Physical Sciences and Industrial Applications. Edited by J. E. Johnson. Sponsored by the Atomic Energy Research Establishment, Harwell, England. Academic Press, Inc., 125 East 23d Street, New York 10, N.Y., 1954. 223 pages, 9½ by 6¼ inches, bound. $7.50. Twenty-four papers delivered in four sessions devoted to the use of radioisotopes in chemistry, metallurgy, physics, and industry included in full, with discussions. Of the wide range of topics dealt with, the following are representative of those of special interest to engineers: the autoradiographic method for study of segregation in metals; isotopes for water flow and velocity measurements; radioactive study of carbide cutting tool life; use of isotopes to overcome electrostatic dangers in hospitals and industry. Two papers deal with Cerium 144 and Thulium 170 as sources of gamma rays for industrial radiography.

RAW MATERIALS FOR ELECTRICAL CABLES. By A. King and V. H. Wentworth. Ernest Benn Ltd., London, England (distributed in United States by John de Graff, Inc., 64 West 23d Street, New York 10, N.Y.), 1954. 362 pages, 8½ by 5½ inches, bound. $7. A comprehensive account of materials for conductors, insulators, and protective outer layers, prepared by a group of experts from the industry. Information is provided on sources; chemical, physical, and mechanical properties; testing; and methods of utilizing, with reference made to pertinent British standards wherever possible. The material, here brought up to date and amplified, appeared previously as a series of articles in the *Electrical Journal*.

SONICS. Techniques for the Use of Sound and Ultrasound in Engineering and Science. By Theodor F. Heuter and Richard H. Bolt. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1955. 456 pages, 9¼ by 6 inches, bound. $10. Intended for the engineer or scientist with no previous training in acoustics, this book covers fundamentals of vibration and sound; transducers for generation and reception; applications in processing, analysis, and testing; and, in the appendix, molecular aspects of sound propagation in fluids. The applications discussed—cavitometry, thickness gauging, oil-well drilling, and others—have been selected to illustrate operating principles and to suggest other uses in many fields.

STORAGE BATTERIES. By George Wood Vinal. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., fourth edition, 1955. 446 pages, 9¼ by 6 inches, bound. $10. A comprehensive and up-to-date treatment of scientific principles, materials of construction, manufacturing processes, theory of reactions, operating principles, and important industrial applications. In this edition obsolete material has been eliminated, all chapters have been revised, and some parts entirely rewritten in order to include information on such changes in the industry as improved lead alloys, increased use of plastic containers, American production of nickel-cadmium batteries, and many other important topics. The bibliographies which are given after some of the chapters have been brought up to date.

TABLE OF SALVO KILL PROBABILITIES FOR SQUARE TARGETS. (Applied Mathematics Series, no. 44) National Bureau of Standards. Available from Superintendent of Documents, Government Printing Office, Washington 25, D.C., 1954. 33 pages, 10½ by 7¾ inches, paper. $0.30. Although the terminology and notations used are associated with missile development, these 4-place tables are useful to engineers generally as they are applicable to problems of planning in which predicted performance of programs, integrated operations, and individual pieces of equipment play an important role.

TABLES OF FUNCTIONS AND OF ZEROS OF FUNCTIONS. (Applied Mathematics Series, no. 37) National Bureau of Standards. Available from Superintendent of Documents, Government Printing Office, Washington 25, D.C., 1954. 210 pages 10½ by 8 inches, bound. $2.25. Eighteen short tables, including hypergeometric functions, Struve functions, Fourier coefficients, etc., some reprinted from various sources, are brought together in this volume for convenience of use. A brief discussion of the scope, origin, and usefulness of the tables is given in the introduction.

TABLES OF THE ERROR FUNCTION AND ITS DERIVATIVES. (Applied Mathematics Series, no. 41) National Bureau of Standards. Available from Superintendent of Documents, Government Printing Office, Washington 25, D.C., 1954. 302 pages, 10½ by 8 inches, bound. $3.25. Error functions are of fundamental importance in many fields of classical and modern physics. The present expanded table is to 15 decimal places at intervals of 0.0001 between 0 and 1 and at intervals of 0.001 in the range from 1 to 5.6. The introduction discusses interpolation and asymptotic expansion methods, and provides a brief bibliography.

THÉORIE ET TECHNIQUE DE LA TRANSMISSION TÉLÉGRAPHIQUE. Volume I: Théorie. By R. Roquet. Éditions Eyrolles, Paris, France, 1954. 248 pages, 11½ by 8½ inches, paper. F.frs. 2,750. The first part of this work deals essentially with the signals themselves, their importance from the information theory standpoint, and the problem of distortion in telegraphic transmission. The second section covers the electrical phenomena of transmission, transient phenomena in the line, and reception demodulation. Part 3 discusses briefly the considerations involved in applying the above theory to practical problems.

TRANSISTOR AUDIO AMPLIFIERS. By Richard F. Shea. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1955. 219 pages, 9¼ by 6 inches, bound. $6.50. This volume, written to provide the practical engineer with the fundamentals of the subject, deals exclusively with the junction-type transistor and its uses in audio amplifiers. Some basic network theory is presented, with minimum use of higher mathematics, as a preliminary to the more specific design material. The large amount of practical information furnished includes data on the variation of transistor parameters with operating point and temperature, and between units. Problems encountered in coupled stages are also discussed, and examples ranging from preamplifiers to relatively high-powered output amplifiers are given. A bibliography is included.

DIMENSIONS AND TOLERANCES FOR MASS PRODUCTION. By Earle Buckingham. Industrial Press, 148 Lafayette Street, New York 13, N. Y., 1954. 164 pages, 11¼ by 8¼ inches, bound. $8. The author discusses the problem of dimensioning with tolerances in relation to production design, tool design, gauge design, production, and inspection, and suggests methods and practices that would eliminate uncertainties in present practice. He also shows how limiting dimensions on detail drawings control conditions of bulk or size, form, position, assembly, operation, or functioning, and how methods for specifying tolerances may be different for each of these conditions. Worked-out examples illustrate the discussion.

ASTM STANDARDS ON ELECTRICAL INSULATING MATERIALS. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1955. 640 pages, 9 by 6 inches, paper. $5.50. Thirty-three of the designations in this compilation are either new or have been revised since publication of the previous edition in 1953. The standards included are of interest to manufacturers, suppliers, and consumers of insulating materials and electric machinery and devices ranging from the heaviest generating equipment to the lightest of electronic components.

ASTM STANDARDS ON WOOD, WOOD PRESERVATIVES, AND RELATED MATERIALS. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1954. 358 pages, 9 by 6 inches, paper. $3.75 (members $2.80). These standards cover evaluation of mechanical and physical properties, methods for chemical analysis, structural grading and specifications of wood and timbers, fire tests of building materials, and specifications and tests for preservatives.

ELECTRICAL EQUIPMENT IN MINES. Edited by H. Cotton. Transatlantic Arts, Inc., Hollywood-by-the-Sea, Fla., 1955. 456 pages, 9¼ by 6½ inches, bound. $12. Each chapter of this survey of the latest techniques and equipment is written by a specialist in a particular branch of the generation, distribution, and utilization of electricity in mines. Detailed information for both mining and electrical engineers is given on power supply, switchgear, cables, air compressors, coal cutters, conveyors, pumps, fans, and winders. Open-pit equipment is fully dealt with, as are lighting systems, haulage, and signaling. Treatment is almost entirely based on British practice.

ELEKTRONISCHE HALBLEITER. By Eberhard Spenke. Springer-Verlag, Berlin, Germany, 1955. 379 pages, 9¼ by 6½ inches, bound. DM 34.50. The first part of this treatise deals with the conducting mechanism of electronic semiconductors and the physics of crystal rectifiers and transistors. The second part presents the fundamental physics of semiconductors with relation to atomic physics, wave mechanics, thermodynamics, and crystallography. Its use extends to engineers and physicists whose interest embraces luminous materials, oxide cathodes, electrolytic condensers, barrier-type cells, and other solid-state problems.

HANDBOOK OF APPLIED MATHEMATICS. Edited by Edward E. Grazda and Morris Brenner, based on the original work by Martin E. Jansson, Herbert D. Harper, and Peter L. Agnew. D. Van Nostrand, Inc., 250 Fourth Avenue, New York 3, N. Y., third edition, 1955. 1,044 pages, 8 by 5½ inches, bound. $7.50. The first six chapters review the fundamentals of arithmetic, algebra, geometry, trigonometry, and differential calculus; succeeding chapters deal with applications to practical problems in the building trades, machine shop work, electricity, electronics, printing, business, and accounting. The book is intended both as a reference manual and as a text for self-instruction.

HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1955. American Society of Heating and Air Conditioning Engineers, Inc., 62 Worth Street, New York 13, N. Y., volume 33, 1955. 1,680 pages, 9¼ by 6 inches, bound. $12. Changes in codes and standards, new methods in product design, and improved engineering practices have been incorporated in the revision. Arrangement and coverage remain unchanged, with a wide range of topics treated under the following broad headings: fundamentals, human reactions, heating and cooling loads, combustion and consumption of fuels, systems and equipment, special systems, and instruments and codes.

MODERN FLUORESCENT LIGHTING. By A. D. S. Atkinson. George Newnes, Ltd., London, England, second edition, 1955. 159 pages, 8¼ by 5½ inches, bound. 15s. A concise treatment of principles and practices written for electrical and illuminating engineers, and architects. It covers the nature of light and fluorescence; principles and characteristics of lamps; illuminating design; cold-cathode tubes; fittings; and applications in factories, offices, homes, etc. Both British and American practice is considered.

MOTION AND TIME STUDY. By Marvin E. Mundel. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y., second edition, 1955. 575 pages, 9¼ by 6½ inches, bound. $9.35. A systematic treatment of modern procedures and techniques for the development of improved work methods and the measurement of human performance. Cases chosen from many different industries and types of works are used to illustrate the discussion of process charts, multiple-activity analysis, predetermined time standards, and the related subjects covered. Six new chapters have been added to this edition.

NUCLEAR PHYSICS. By Alex E. S. Green. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1955. 535 pages, 9½ by 6 inches, bound. $9. Primarily concerned with theories and experiments relating to the characteristics, behavior, and internal structure of nuclei, this comprehensive introduction to the field reviews the background material of atomic physics and discusses the following major topics: instruments and methods; experimental results and their interpretation; systematics and semiempirical theory; and nuclear theory. A chapter covering the essentials of quantum mechanics is included to provide a basis for understanding the chapters on theory.

AN OUTLINE OF ATOMIC PHYSICS. By Oswald H. Blackwood and others. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., third edition, 1955. 501 pages, 9¼ by 6 inches, bound. $7.50. Intended for readers with a knowledge of elementary physics, this book deals with the structure of atoms and molecules and the nature of radiation as revealed by modern physical science. Certain topics in the new physics—for example, nuclear fission and cosmic rays—are treated, as well as are the more established subjects such as the periodic system, the Bohr model of the atom, etc.

PRACTICAL ELECTROACOUSTICS. By Michael Rettinger. Chemical Publishing Company, Inc., 212 Fifth Avenue, New York 10, N. Y., 1955. 271 pages, 8½ by 5½ inches, bound. $10. Concerned chiefly with the description and analysis of microphones, moving-coil loudspeakers, mixers, magnetic recording devices, and other units of audio equipment. Also discussed are such related subjects as crossover networks, attenuators, magnets, vibration isolation, audio construction, and measurement of sound-absorbing materials. Working formulas and design curves are included as an aid to designers.

PRINCIPLES OF ELECTRIC UTILITY ENGINEERING. By Charles A. Powel. Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1955. 251 pages, 9¼ by 6 inches, bound. $6. A concise review of problems basic to the design and operation of a utility, this book covers the whole field from sources of energy to power distribution, and includes an introductory chapter on corporate organization, objectives, and finance. The book is useful as an over-all view of the industry to those employed in one of its branches, and as a text for college or training courses.

DIE WICKLUNGEN ELEKTRISCHER MASCHINEN. Volume III: Wechselstrom-Sonderwicklungen. By Heinrich Sequenz. Springer-Verlag, Vienna, Austria, 1954. 397 pages, 9¼ by 6¾ inches, bound. $17.40. This third of a 4-volume set on windings of electric machines considers special windings of a-c machines: pole-changeable windings; short-pitched windings; windings for heavy current; asymmetrical, voltage- and phase-reversible windings; windings with equipotential connections.

AIR CONDITIONING, REFRIGERATING DATA BOOK. Applications Volume. American Society of Refrigerating Engineers, 234 Fifth Avenue, New York 1, N. Y., fifth edition, 1955. Various paging, 9½ by 6½ inches, bound. $7.50. Sixty-one chapters on the art and science of refrigeration are grouped in eight divisions covering frozen foods, food industries, warehouse practice, food distribution, low temperature applications, industrial applications, comfort air conditioning, and industrial air conditioning. The chapters on fishing boats, precooling, and passenger automobiles are new, and a number of chapters have been extensively revised.

AMERICA'S NEEDS AND RESOURCES: A NEW SURVEY. By J. Frederic Dewhurst and Associates. Twentieth Century Fund, 330 West 42d Street, New York 36, N. Y. 1955. 1,148 pages, 10¼ by 6¼ inches, bound. $10.00. This encyclopedic survey of the past achievements, present status, and future possibilities of the American economy is some 50 per cent greater in length than its predecessor of the same title published in 1947. Its 26 chapters give statistical and analytical information on consumption goods and services, capital requirements, government expenditures, foreign trade, the labor force, natural resources, and productive capacity. Special attention is given throughout to the impact of new products and techniques, and two chapters are devoted to technological change and its effect on productivity.

BASIC ENGINEERING SCIENCES. Revised edition, 100 pages, 11 by 8½ inches, paper. $3.00. Also **PROBLEMS AND SOLUTIONS—NEW YORK STATE PROFESSIONAL ENGINEERING EXAMINATIONS, PARTS II AND III.** 1950 through 1954. 105 pages, 11 by 8½ inches, paper. $2.25. By Carlos E. Harrington, 45 Elk Street, Springville, N. Y. The first of these booklets for engineers preparing for New York State examinations contains a brief review of fundamentals and answers to 195 questions asked in previous examinations. The second contains 219 problems in economics and practice, hydraulics, machine design, thermodynamics, and hygrometry, taken from examinations, 1950–1954.

BASIC LUBRICATION PRACTICE. By Allen F. Brewer, Reinhold Publishing Corporation, 430 Park Avenue, New York, N. Y. 1955. 286 pages, 9½ by 6 inches, bound. $6.75. Practical methods for lubricating machine parts, mechanisms, steam turbines, internal combustion engines, electric motors, and other types of machinery are discussed as an aid to engineers and others concerned with the selection and use of effective lubricants. Automatic lubrication, operating conditions affecting lubrication, physical tests, storage, handling, and reconditioning are also treated, and non-petroleum lubricants are considered briefly.

THE CONTROL OF QUALITY IN THE PRODUCTION OF WROUGHT NONFERROUS METALS AND ALLOYS. Part II. The Control of Quality in Working Operations. (Monograph and Report Series, no. 16) Institute of Metals, London, England, 1954. 87 pages, 11½ by 8¼ inches, bound. $2.50. The five papers presented cover the following topics: control of dimension, shape, and finish in rolling of sheet and strip and in the drawing of wire; control of quality in the hot and cold rolling of aluminum and aluminum alloys; control of properties and structure in hot and cold rolling of copper and copper-base alloys; factors affecting the quality of extrusions; and statistical control in metal-working operations. Name and subject indexes are included.

ELECTROCHEMISTRY IN BIOLOGY AND MEDICINE. Edited by Theodore Shedlovsky. Sponsored by the Electrochemical Society, Inc. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1955. 369 pages, 9½ by 6 inches, bound. $10.50. An outgrowth of a symposium held by the Electrochemical Society, this book presents a survey of current thought on the fundamental electrochemical problems of living processes. The several chapters, contributed by specialists, deal with bioelectric potentials, the electrochemistry of membranes, diffusion in liquids, electrocardiography, electroencephalography, and other similar topics.

ELECTRON AND NUCLEAR COUNTERS. Theory and Use. By Serge A. Korff. With a chapter on scintillation counters by H. Kallmann. Second edition, 1955, D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. 363 pages, 9½ by 6½ inches, bound. $6.75. A summary of basic information on the discharge mechanism and practical operation of various types of counters, intended for users of these instruments. The book covers proportional, Geiger, and scintillation counters, ionization chambers, preparation and construction of counters, errors and corrections in counting and auxiliary electronic circuits. In this edition, a number of topics have been extended, some obsolete circuits have been deleted, and the bibliography has been brought up to date.

ELECTRONIC CIRCUITS. By Thomas L. Martin, Jr. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y., 1955. 707 pages, 8½ by 5½ inches, bound. $12.00. The first part of this study is a brief introduction to equivalent circuits and circuit theory based on the complex frequency and La Place transform approach. Part 2 covers circuits requiring continuous operation of the electronic component: single-stage and multi-stage amplifiers, feedback circuits, transistor amplifiers, etc. Part 3, mainly on circuits requiring discontinuous operation of the electronic component, takes up such topics as power amplifiers, modulators, magnetic amplifiers, and waveshaping and computing circuits. Intended for practicing engineers and advanced students, the book is almost entirely analytical in approach.

ELEKTRISCHE MASCHINEN. Volume IV: Die Induktionsmaschinen. By Rudolf Richter. Verlag Birkhäuser, Basel, Switzerland, second edition, 1954. 440 pages, 9¼ by 6½ inches, bound. Sw. frs. 36.40. A standard treatise on induction machines which is part of a series covering the whole range of electric machinery. This second edition is a corrected photomechanical reprint of the book originally published in 1936. It contains an added section which surveys advances made since 1936 and brings the bibliography up to date.

ELEKTROLYTISCHE ABSCHEIDUNG UND ELEKTROKRISTALLISATION VON METALLEN (Reine und angewandte Metallkunde in Einzeldarstellungen, no. 12) by Hellmuth Fischer. Springer-Verlag, Berlin, Germany, 1954. 717 pages, 9¼ by 6¼ inches, bound. DM 72.00. In this treatise on electrodeposition and "electrocrystallization" of metals the author defines the latter term as covering all aspects of electrodeposition of a metal on a cathode with formation of a solid crystalline phase. In addition to the extensive treatment of the deposition process and its results, the book gives the electrochemical fundamentals, the general properties of cathodic metal deposits, and the properties of deposits of specific metals and alloys.

ELSEVIER'S DICTIONARY OF TELEVISION, RADAR AND ANTENNAS. In six languages: English-American, French, Spanish, Italian, Dutch, and German. Compiled and arranged by W. E. Clason. Elsevier Publishing Company, 2330 Holcombe Boulevard, Houston, Tex., 1955. 760 pages, 9 by 6 inches, bound. $21.50. The first of a new series of polyglot technical dictionaries relating to special fields of science and industry. The basic word list is in English (British and American usage being clearly distinguished), and definitions in English are given for each term. Equivalents in other languages are arranged horizontally across facing pages, and are also given in alphabetical lists numerically keyed to the English list. Slang and code words are included.

HANDBUCH DER KALTETECHNIK. Edited by R. Plank. Volume I: Entwicklung, Wirtschaftliche Bedeutung, Werkstoffe. Edited by J. S. Cammerer and others. 1954, Springer-Verlag, Berlin, Germany. 567 pages, 6½ by 10 inches, bound. DM 84.00, in subscription DM 67.20. This is volume I of a projected comprehensive 12-volume series on all aspects of refrigeration. The first half of the book covers historical developments, general applications, and economic importance. The last half provides detailed information on the various materials used, varying from a general discussion of the characteristics of metals of all sorts to specific data on thermal and electrical indulation.

INDUKTIVITÄT UND KAPAZITAT DER STARK-STROM-FREILEITUNGEN. By R. Brüderlink. Verlag G. Braun, Karlsruhe, Germany, 1954. 87 pages, 8¼ by 5⅞ inches, bound. DM 14.20. This concise text is intended to provide detailed explanations of calculations for inductance and capacitance in high-voltage overhead transmission lines, particularly those which are usually omitted from textbooks on electric conductors. A rigorous mathematical approach is employed. Reciprocal effects of electric and magnetic fields are also considered.

AN INTRODUCTION TO STOCHASTIC PROCESSES. With special Reference to Methods and Applications. By M. S. Bartlett Cambridge University Press, 32 East 57th Street, New York 22, N. Y. 1955. 312 pages, 8¼ by 5½ inches, bound. $6.50. A general, although fairly rigorous, survey of statistical techniques applicable to a wide range of actual processes that involve some statistical or chance element. These processes occur throughout the field of physics; the communication engineer, for example, will find material relevant to prediction and communication theory. A considerable bibliography, arranged by chapters, is appended.

PRINCIPLES AND PRACTICE OF ELECTRICAL ENGINEERING. By Alexander Gray. Revised by G. A. Wallace. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., seventh edition, 1955. 598 pages, 9¼ by 6¼ inches, bound. $7.50. A standard text covering fundamentals of electrical physics; operating principles of generators, motors, batteries, amplifiers, etc.; and electric and magnetic circuits. In this edition many of the articles are new or rewritten, the most thorough revision occurring in the chapters on thermionic tubes, induction motors, synchronous motors, and transformers.

PROCEEDINGS OF THE SYMPOSIUM ON INFORMATION NETWORKS. Sponsored by Polytechnic Institute of Brooklyn, Microwave Research Institute. Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn 1, N. Y., 1955. 328 pages, 9¼ by 6 inches, bound. $5.00. These proceedings include 23 papers of which several are general discussions on the relationship between information theory and network theory, and the others are discussions of special topics relevant to these fields; Wiener filters, structure in communication networks, design of digital coding networks, the logical approach to design of computer networks, and others.

SOME FUNDAMENTALS OF COMBUSTION. (Gas Turbine Series, volume 2). By D. B. Spalding. Academic Press, Inc., 125 East 23d Street, New York 10, N. Y., 1955. 250 pages, 6 by 9¼ inches, bound. $7.50. Brief chapters are included on selected aspects of heat and mass transfer, thermodynamics, and fluid flow; somewhat longer chapters on heat and mass transfer with chemical reaction and chemical features of combustion. The latter deal with such specific topics as combustion of gas jets, combustion of premixed gases, and combustion without premixing. Some of the guiding principles for gas turbine design are discussed in the concluding chapter.

PAMPHLETS • • • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Engineering Teaching Aids. Nearly 300 teaching and learning aids in three branches of engineering and in mathematics and mechanics are described in "Educational Aids in Engineering," an illustrated indexed catalogue published by the American Society for Engineering Education (ASEE). Future editions will cover other engineering branches and additional service areas. The 285 educational aids accepted by the ASEE Teaching Aids Committee, originator and sponsor of the project, were culled from a first list of 5,000 aids. Training devices designed to teach specific skills were not included. The brochure outlines needs and procedures for further research in the production of demonstration models, motion pictures, film strips, slides, wall charts, and other learning and teaching aids. It also urges industry to improve the educational aid it produces. The percentage of such aids which are of good quality is low, the committee says. Universities and government agencies exceeded industry in the percentage of their educational aids which the committee found acceptable. Many of the academic aids were produced at little cost. By fields, civil engineering led in percentage of acceptable aids. Eighty-three of its final 171 items were regarded as of high quality. Corresponding figures for the other branches are: electrical engineering, 46 of 320; mechanical engineering, 47 to 140; mathematics, 24 of 60; and engineering mathematics, 85 to 240. 72 pages. $1.00. Copies of "Educational Aids in Engineering" are sold by the Executive Secretary of the American Society for Engineering Education, 1201 West California, Urbana, Ill. He asks that payment accompany each order.

Prevention and Control of Disaster Situations. Definite steps for the prevention and, when necessary, control of emergency disaster situations in plants and places of public assembly are presented in three booklets now available from the Association of Casualty and Surety Companies. "Before Disaster Strikes" presents a plan of organization for disaster control and describes the duties of each member of the organization. It gives information on emergency warning and communication systems, training employees, conducting drills, maintaining morale, and preparing the plant for emergencies. It discusses, in turn, procedures for meeting disaster from fire, flood, windstorms, sabotage, air raids, and germ attacks. This booklet was designed for use principally by larger plants, but the methods given are easily adaptable to organizations of any size. "Fire Control" is a manual presenting in greater detail accepted procedures for handling fire protection equipment and methods of preventing industrial fires. It is designed to serve as a guidebook for plant management, supervisors, and other personnel concerned directly with fire safety. Included in the booklet is a table on fire extinguishers which provides all the basic data usually required to use these devices effectively. The third booklet, "Panic and Its Control," was written by Dr. Walter Cutter of the Center for Safety Education at New York University, New York, N. Y. The pamphlet covers the nature and causes of panic, as well as its prevention and control. It is a guide for controlling panic-evoking situations and for handling panic when it arises in places of public assembly. 10¢. Each of the pamphlets is available with special price reductions for orders of 100 copies or more. Orders should be addressed to the Association of Casualty and Surety Companies, Accident Prevention Department, 60 John Street, New York 38, N. Y.

Specification for Dry Cells and Batteries. The sixth edition of the American standard "Specification for Dry Cells and Batteries" was approved as American Standard on August 19, 1954. It supersedes the previous specification, which was approved August 6, 1947, and published in Circular *466* of the National Bureau of Standards. Within the past few years new types of cells have been developed to meet new industrial uses, and the available electrical output of better brands of the older types have been materially increased. Successive editions of this specification have reflected these changes. This edition of the specification includes, for the first time, specifications on flat cells and new alkaline primary cells known as "mercury cells." Previous editions were confined to cylindrical Leclanché types. Mercury cells were produced initially during World War II for military applications and later found commercial use principally in hearing-aid instruments. Also, air-depolarized cells in miniature size that have been developed as replacements for other types of dry cells used in hearing-aid instruments are covered by the present revision of the American Standard. 117 pages. 25¢. Order "Specification for Dry Cells and Batteries," National Bureau of Standards Circular *559*, from the Government Printing Office, Washington 25, D. C. Foreign remittances must be in U. S. exchange and should include an additional one third of the publication price to cover mailing costs.

Unionization of Professional Engineers. The Engineering Societies Library has prepared a "Bibliography on Unionization of

Professional Engineers" to answer inquiries received by the Library from engineers, engineering students, and others interested in the subject. The 100 references are to pamphlets and articles in magazines from 1937 to 1954 which are in the Engineering Societies Library. 8 pages. $2.00. Write for ESL Bibliography No. 10: "Bibliography on Unionization of Professional Engineers," Engineering Societies Library, 29 West 39th Street, New York 18, N.Y.

Standards for a Strong America. What effect will international electrical standards have on the future of the electrical industry? This and other questions concerning the United States participation in the International Electrotechnical Commission, and questions concerning U.S. foreign trade, are answered in the proceedings of the Fifth National Conference on Standards, held in November 1954 at the Hotel Roosevelt, New York, N. Y., published by the American Standards Association. Entitled, "Standards for a Strong America," the volume contains 40 papers on a wide variety of subjects, including international electrical standards and world trade, purchasing, architecture, safety, color television, company standardization, quality control, agriculture, forecasts by technical and business press editors, and the annual meeting of the American Standards Association and award ceremony addresses. $3.00. It is now available from the American Standards Association, 70 East 45th Street, New York 17, N. Y.

Radio and Television Interference. One of the serious problems which prevails in the home entertainment field by means of radio and television, is the matter of interfering signals generated by electric devices used in homes, by industry, and other types of facilities including the electric power companies. Fred D. Rowe, who has been in the employ of the Northern California Electric Bureau for many years as the chief investigator in connection with the location and elimination of radio and television interference, has written a book about the kinds of devices which are generators of interfering signals. He also tells how to locate these devices and exactly what to do to correct the difficulties. The book is "How to Locate and Eliminate Radio and TV Interference." It is published by John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. 122 pages. $1.80

Defense Materials System. This booklet, "The Defense Materials System (DMS) in Our American Industry" is now on sale by the Superintendent of Documents, Government Printing Office, and the Department of Commerce Field Offices. Sinclair Weeks, Secretary of Commerce, in "A Message for Industrial Management," that serves as a foreword, stresses the need for a "functioning material control system designed to permit rapid industrial mobilization in case of war." "DMS serves this purpose," the foreword continues. "The rules have been made simple. All except the most essential paper work has been eliminated. Industrial contractors and subcontractors for programs of the Department of Defense and the Atomic Energy Commission have the responsibility for acquainting themselves with the few remaining rules and regulations. This manual is designed to aid in this task. It has been arranged so that each type of contractor and supplier may find a handy reference to the general rules applicable to his defense contract operations." Key questions and answers on the essential points of the Defense Materials System precede the detailed description and instructions for defense contractors. In recognition of the importance of the Defense Materials System to our national security, the Department of Defense requires all of its contractors to agree that they will follow the provisions of applicable rules and regulations of the Business and Defense Service Administration, including DMS Regulations, in the procurement and use of materials required for the performance of their contracts. 41 page. $0.25

The Heating Ventilating Air Conditioning Guide 1955. This is the 33d edition published by the American Society of Heating and Air-Conditioning Engineers (ASHAE). It contains latest technical and equipment information, and is both larger and improved in content. The many revisions and expansions are the result of research by the society and others, changes in codes and standards, new methods in product design, and improved engineering practices. However, despite the many improvements, the appearance and arrangement of the chapters is the same, and the 53 chapters are grouped as: I—Fundamentals; II—Human Reactions; III—Heating and Cooling Loads; IV—Combustion and Consumption of Fuels; V—Systems and Equipment; VI—Special Systems; and VII—Instruments and Codes. Also retained are the edge indexes in both the technical and catalogue data sections, and classified subject and product indexes; and the 24- by 32-inch ASHAE psychrometric chart is still includes. The changes include several rewritten chapters, a new chapter on schoolhouse heating and ventilating, new information on heating systems using high-temperature hot water, and reorganized design information on thermal conductivities and conductances for pipe insulation and building materials. In addition, there are major revisions and changes in many of the chapters. 1,160 pages, technical session; equipment section concerns 328 manufacturers. $12.00 Send orders to: American Society of Heating and Air-Conditioning Engineers, 62 Worth Street, New York 13, N.Y.

Proceedings of the National Electronics Conference, 1954. These proceedings are available by writing to: National Electronics Conference, 84 East Randolph Street, Chicago 1, Ill. This book contains all of the technical papers and luncheon addresses presented at the 1954 conference and a cumulative index by subject and author of all of the technical papers presented during the 10-year life of the National Electronics Conference. The 86 technical papers cover electronic research, development, and application of antennas, circuits, communication, computers, electron tubes, engineering management, instrumentation, managnetic amplifiers, materials and components, microwaves, radar, servomechanisms, solid-state devices, and television. 872 pages. $5.00. Volumes 2, 4, 5, 6, 7, 8, and 9 may also be obtained for $5.00 per copy.

Speaking Can Be Easy for Engineers. This is a pocket-sized illustrated manual for better speaking and meetings. Among subjects covered in this manual are: selecting the type of presentation, planning and preparing, attention patterns, platform manners, visual aids, microphone techniques, effective chairmen, introductions with a punch, handling the questions, panel discussions, and bigger and better audiences. 24 pages. 50¢ each. "Speaking Can Be Easy for Engineers" is a report of the American Society for Engineering Education and only a limited number of copies are available. Write to: Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y.

Power-Line Anchoring. "Anchoring for Power and Communication Lines," a completely illustrated manual on improving line construction with better anchoring, contains sections on anchor designs, field testing, selecting anchors, soil classifications, installation tools, installation procedures for each type of anchor, guying practices, charts on wire sizes and strengths, typical fixture combinations, and special applications. Installation procedures are completely illustrated so they can be easily followed step by step. Section on guying practices shows simple ways of determining line loads on dead ends and angle lines and calculating guy loads. Copies of this manual are available free of charge from the Advertising Department of the A. B. Chance Company, Centralia, Mo.

Modern Material Handling. "Modern Material Handling," a 32-page publication of the Edison Storage Battery Division of Thomas A. Edison, Inc., has been revised to include illustrations of modern industrial trucks with the latest materials handling attachments. The publication is devoted to the unit-load principle, the power requirements of industrial trucks, and the characteristics of Edison nickel-iron-alkaline storage batteries. Copies are available on request. Write to: Edison Storage Battery Division of Thomas A. Edison, Inc., West Orange, N. J.

Bibliography on Industrial Radiology. The "Bibliography on Industrial Radiology, 1952–54" is by Herbert R. Isenburger. This is the fifth supplement to "Industrial Radiology" published by John Wiley and Sons, New York, N. Y., 1943. Included are references 3021 to 3697. 24 pages. $3.00.

Basic Electronics. "Basic Electronics" comes in five volumes which constitute a home study course without correspondence questions and answers. Each volume is devoted to a number of subjects which gradually develop the course. Total of 560 pages. $2.00 per volume, $9.00 for the set. John F. Rider is publisher, 480 Canal Street, New York, N. Y.

INDUSTRIAL NOTES ....

General Electric News. Gordon T. Graham has been named manager of marketing for the General Electric Company's small integral motor department. In 1954 Mr. Graham was named manager of the Dayton, Ohio, sales office, the position he retained until his present appointment.

Appointment of Harry L. Thorson as manager of transmitting tube product engineering for the power tube subdepartment has been announced. In his new position, Mr. Thorson will be responsible for all product design of gaseous discharge power control tubes, vacuum rectifiers and power tubes, and camera and storage tubes.

North American Establishes Atomic Division. North American Aviation, Inc., has strengthened its organization in the commercial field of atomic energy by establishing a separate Nuclear Engineering and Manufacturing Division, and electing Dr. Chauncey Starr as vice-president in charge. North American will provide all services necessary for reactor development, manufacture, and operation through this integrated Nuclear Engineering and Manufacturing Division. Operations of the division will include the designing, developing, and servicing of nuclear reactors for medical, industrial, and scientific research, and the generation of electric power. Dr. Starr has directed North American's atomic energy research and development program since the company entered the field. The division's headquarters will be near the site of the North American-designed Sodium Reactor Experiment which is now under construction in the Santa Susana Mountains, Calif.

Westinghouse Notes. H. Ward Hahir, manager of engineering for a Naval Ordnance project at the Westinghouse Electric Corporation plant, Sunnyvale, Calif., has received the company's highest honorary award, the Westinghouse Order of Merit. The award was voted by the Westinghouse Board of Directors for Mr. Hahir's "significant technical contributions" to the development of an antiaircraft gun for shipboard use by the United States Navy, and for guiding the tests of the completed gun in Dahlgren, Va.

Bruce D. Henderson, vice-president of Westinghouse Electric Corporation, Pittsburgh, Pa., has been appointed to the apparatus products staff, and A. M. Kennedy, Jr., has been appointed general manager—purchases and traffic, succeeding Mr. Henderson. Since 1952 Mr. Kennedy has been assistant general manager of purchases. In his new position Mr. Henderson will be concerned with personnel and organization with reference to product departmentalization. Besides these staff functions, his line responsibilities will include the director systems and materials manufacturing departments.

Bendix Names New Staff Men. Two appointments to the staff of the Research Laboratories Division of Bendix Aviation Corporation has been announced. Ralph A. Lamm has been appointed to head special missile development activities of the division. He will be responsible for coordinating the guidance and control developments in special missile fields for the corporation. He will be stationed at headquarters of the Pacific Division, North Hollywood, Calif. Arthur C. Prine has been named assistant to the general manager of the division. His duties will include customer relations and market research.

RCA Changes. Appointment of C. W. Taylor to the newly created position of manager—color kinescope marketing, RCA Tube Division, Radio Corporation of America, has been announced. For the past 10 years, Mr. Taylor has acted as manager, tube parts and machinery sales. In his new assignment he will be responsible for market planning and promotion of color television picture tubes. During World War II, he assisted in the manufacture of cathode-ray tubes for radar, transferring in 1943 to the RCA tube plant at Lancaster, Pa.

G. Warren Kimball has been named manager—battery and renewal components marketing, of the RCA Tube Division. Mr. Kimball will direct market planning and controls for RCA batteries and renewal components.

Philco Names New TV Executives. Appointment of Reese B. Lloyd, director of industrial and personnel relations for Philco Corporation, as vice-president in charge of operations for the Television Division, has been announced. At the same time William H. Mattison was named vice-president in charge of production for television. Mr. Lloyd succeeds William J. Peltz, recently named vice-president and general manager of the Lansdale Tube and Transistor Company Division of Philco.

New Managers Named. Appointment of new managers in three Minneapolis-Honeywell Regulator Company field offices has been announced. They are O. V. Spousta who is being transferred from the company's branch office in Louisville, Ky., to manage its newly opened office in Hammond, Ind.; W. C. Waltman, who moves from South Bend, Ind., to Louisville; and George Rossiter, who replaces Mr. Waltman as manager of the company's district office in South Bend.

ElectroData Executives Assume New Posts. The appointment by the ElectroData Corporation board of directors of

(*Continued on page 26A*)

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AIEE REPORTS

These publications are proposals for new standards or test codes, or revisions of present publications, which are in the formative stage. They are made available **without cost**, so that all interested individuals may obtain them for study and comment, thereby supplying practical experience in their use before submission for adoption.

- **1A** General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (September 1941)
- **1C** Test Code for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery (January 1954)
- **16A** Electric Control Apparatus for Land Transportation Vehicles (April 1951)
- **51** Guiding Principles for Dielectric Tests (September 1949)
- **82** Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases (March 1951)
- **83** Guide for Operation and Maintenance of Dry Type Transformers with Class B Insulation (October 1952)
- **84** Standard Test Code, and Recommended Practice for Induction and Dielectric Heating Equipment (October 1952)
- **56** Insulation Maintenance Guide for Large A-C Rotating Machinery (May 1954)
- **450** Guide for Specification of Electronic Voltmeters (April 1955)
- **451** Guide for Specification of Signal Sources (April 1955)
- **452** Guide for Specification of Cathode-Ray Instruments (April 1955)
- **502** Test Code for Single-Phase Motors (November 1941)
- **504** Test Code for Carbon Brushes (October 1953)
- **505** Proposed Test Code for Power Factor Testing of Power Transformers (January 1955)
- **802** Test Code for Carbon-Pile Voltage Regulators for Aircraft (April 1955)
- **954** Application Guides for: Ground-Fault Neutralizers; Grounding of Synchronous Generator Systems; and Neutral Grounding of Transmission Systems (October 1954)

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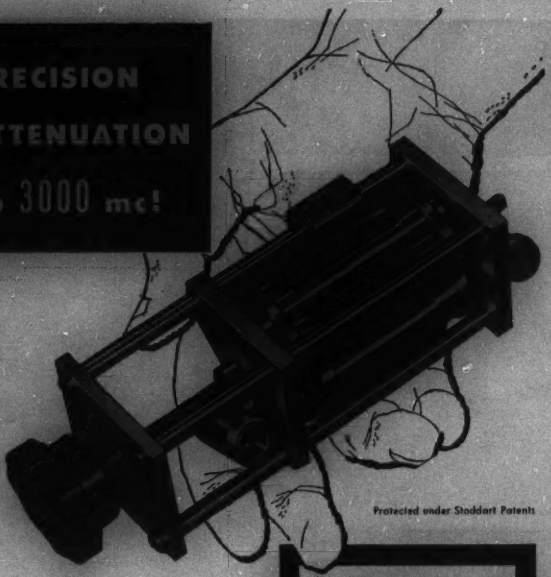

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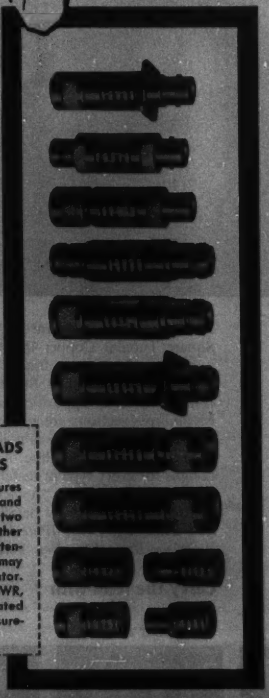

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(*Continued from page 21A*)

Joseph B. Rice as vice-president—manufacturing, and George B. Holmes as assistant treasurer has been announced. Mr. Rice will continue to serve as assistant secretary of the Pasadena, Calif., digital computer firm, an affiliate of Consolidated Engineering Corporation. Mr. Holmes previously was chief accountant.

AEC Assistant General Manager Named. The appointment of David F. Shaw as assistant general manager for manufacturing, Atomic Energy Commission, has been announced. Mr. Shaw, who has been manager of the Hanford Operations Office, Richland, Wash., since 1950 will assume his new duties on June 6, 1955.

It was also announced that James E. Travis, assistant manager at Hanford, has been designated acting manager of the Hanford office.

Vice-President Named. Dr. A. B. Kinzel has been elected vice-president—research, of Union Carbide and Carbon Corporation, succeeding Dr. George O. Curme, Jr. Dr. Curme, who is retiring as vice-president of the corporation, will continue as a director. Dr. Kinzel has been engaged in research work with Union Carbide and Carbon Corporation since 1926, when he joined Electro Metallurgical Company as a research metallurgist.

General Cable News. General Cable Corporation has entered into a contract for the acquisition of General Insulated Wire Works, Inc., of Providence, R. I. C. J. Craig, president of General Insulated Wire Works, will be appointed a vice-president of General Cable, with principal responsibility for the Providence operation. General Cable now operates six plants, located in Bayonne and Perth Amboy, N. J.; Rome, N. Y.; St. Louis, Mo.; Los Angeles and Emeryville, Calif.

General Cable Corporation plans to construct a modern, new plant in Monticello, Ill. The new plant will occupy 50,000 square feet. It will be equipped with modern manufacturing facilities. New units will be added as necessary to meet the needs for additional production. This new manufacturing facility will increase the company's production of paper telephone cable by approximately 25 per cent. R. E. Riggin, presently assistant plant manager at General Cable's St. Louis, Mo., factory, will take over the management of the new plant.

Arrangements with Canada Wire and Cable Company Ltd., for the formation of a new company to manufacture a complete line of telephone wires and cables in Canada have been made. The new company, Telecables and Wires Ltd., will be owned jointly by General Cable, Canada Wire and Cable, and the British firm of Telegraph Construction and Maintenance Company Ltd. Canada Wire and Cable Ltd. will operate the new company plant, which will be in full operation within one year. The factory is expected to be located in or near Winnipeg, Ont. Officers of the new

(*Continued on page 30A*)

POLYSTYRENE CLOSE TOLERANCE MINIATURE CAPACITORS *are constructed with* NATVAR Styroflex® FILM

EFCON Polystyrene Capacitors manufactured by Electronic Fabricators, Inc., New York, have become standard for the electronic industry. They were developed for uses where high insulation resistance, low power factor and low leakage are necessary. These miniature capacitors are used extensively for filters, timing circuits, computers, and similar applications where close tolerances are essential.

Temperature and humidity are closely controlled in the winding department, and air is filtered to protect against dirt, dust, or other contamination.

Each unit, from start to finish, is checked at least 5 times for voltage and capacitance before being shipped. In this step, capacitors are tested at DC voltages at least 200% of rated voltage at 25°C.

These polystyrene capacitors are made to tolerances closer than ± 1%. Their development was made possible by the application of Natvar Styroflex® dielectric due to its flexibility, toughness, and uniformity.

In fact a distinguishing characteristic of all Natvar flexible insulations is that they are always uniform and always the same no matter where purchased.

NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800 — CABLE ADDRESS NATVAR: RAHWAY, N. J.

203 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

NO. 8 IN A SERIES ON ASSURED POWER CONTINUITY

...Why you should insist on Double-Source Control and Full Phase Protection in your Automatic Transfer Switch

Fundamental to the effective operation of an automatic transfer switch is the principle that the operating power for the switch must be obtained from the monitored source to which the load is being transferred. The reason for this is clear: the transfer might be made to an inadequate source or transfer may be impossible despite the availability of the preferred or normal source of supply.

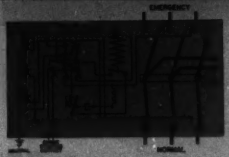
ASCO Automatic Transfer Switches operate on this *double-source control* principle. And, additional protection is built into ASCO equipment through the use of a monitoring lockout relay to assure load transfer only when the new source reaches the proper voltage and frequency. Until this condition is reached the switch is mechanically held to the original source utilizing whatever power is still available.

For vital *full-phase protection*, ASCO industrial type voltage relays constantly monitor all phases of the normal source so that a drop in voltage or failure of one leg on three-wire, or phase failure on four-wire automatically initiates transfer. Full phase relays will start transfer when voltage at the normal source drops to 70% or less. Restoration to normal cannot be made until all phases are 90% or more. For critical loads full phase relays are furnished with adjustable drop-outs set as high as 90% with pick-up at 95%.

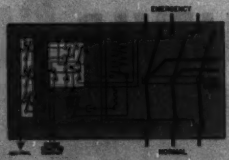
To see why only ASCO-designed Automatic Transfer Switches provide all these essential provisions against power outage, study the accompanying wiring diagrams which briefly explain the switching operation and its built-in protective design.

COMPARE . . .
then insist on ASCO Automatic Transfer Switches. No other switch can give you such sure and complete protection.

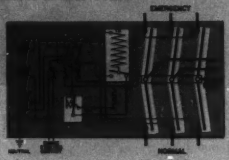
ASCO
Automatic Transfer Switches



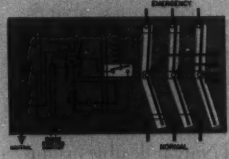
1. Normal functioning of ASCO Automatic Transfer Switch. Full phase protection is provided by Voltage Relays 1V, 2V and 3V.



2. Normal source voltage drops below 70%. Voltage Relays open, de-energizing Source Selector Relay SE. Lockout Relay LO is still open, waiting for emergency source to attain proper voltage and frequency. Load is still connected to original source because of mechanically held movement in ASCO Switch.



3. Emergency source now adequate. LO closes, permitting coil TS to be momentarily energized, causing transfer to proceed. Note double-source control: operating power for transfer is obtained from the source to which the load is to be transferred. Transfer occurs instantaneously!



4. Transfer has taken place. Emergency power is feeding the load. Switch remains on emergency source until Full Phase Relays perceive restoration of normal source to 90% or better. At that time Relays effect closing of top contacts of SE and return to normal source occurs.

THIS INFORMATION SHOULD BE IN YOUR FILES...

For complete data write for Publication 502 and the other advertisements in this series. They explain in detail the efficient functioning of ASCO Switches.

(*Continued from page 26A*)

company are: chairman of the board, J. R. Bradfield; vice-chairman, I. T. Bennett. Other officers include: O. W. Titus, president; J. R. MacDonald, vice-president, and L. G. Lumbers, vice-president.

Motorola Expands. Ground was broken recently for Motorola's new $1\frac{1}{2}$-million transistor manufacturing facility in Phoenix, Ariz. Upon completion the entire building and its equipment will be devoted to the research, development, and production of transistors and other semiconductor devices. Located at McDowell Road and 52d Street in Phoenix, the building will be only a short distance from the company's engineering research and development center. John T. Hickey, staff assistant to Daniel E. Noble, vice-president, Communications and Electronics Division, will coordinate the new operation with the Chicagoland headquarters.

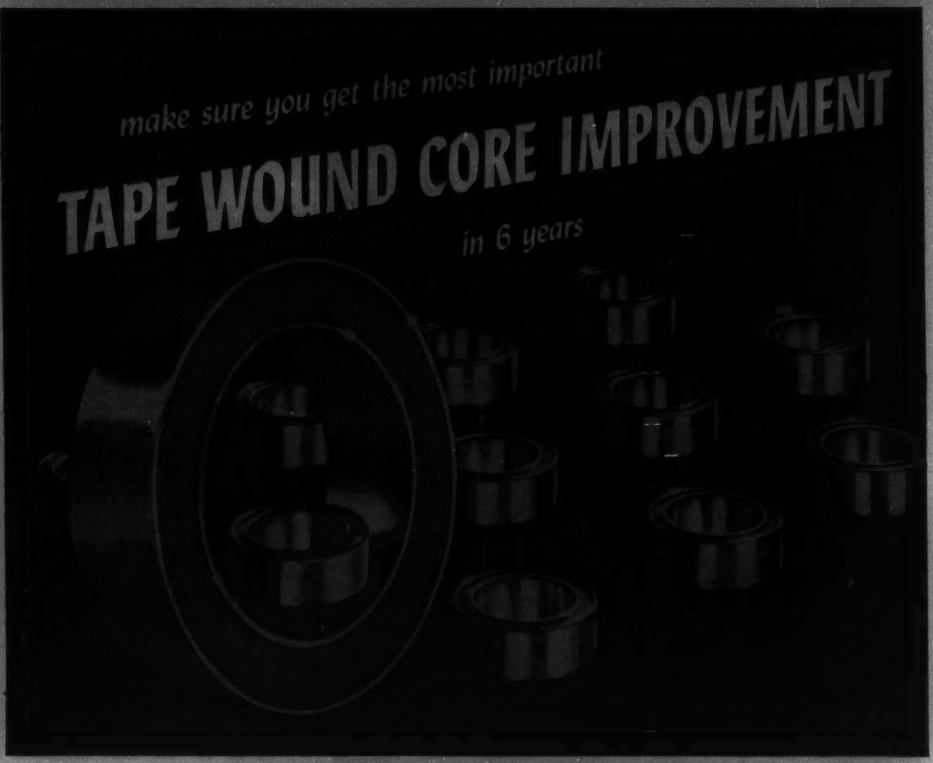
New Division Formed. Ampex International has been formed as a new division of Ampex Corporation. Designed to expand Ampex's business to countries outside of the United States, the formation of Ampex International is another step forward in Ampex's expansion program. Managing director of Ampex International is T. Kevin Mallen, vice-chairman of the Ampex board of directors, presently located in Europe. Assisting him from the Redwood City, Calif., plant is Harrison Johnston, director of the new division.

NEW PRODUCTS . .

Clip-Type Rectifier. A new snap-in type rectifier featuring a clip arrangement which does not require tools for assembly, speeds assembly time, and completely eliminates broken studs, has been announced by the Radio Receptor Company, Inc., of Brooklyn, N. Y. The device, known as Qui-klip, was developed in conjunction with the Tinnerman Products Corporation of Cleveland, Ohio. It does not require special sockets for mounting, only needing two round holes to be snapped into place. In addition, solderless connectors are available for making electrical contact to the rectifier.

Silicone Rubber. Development of a new type of silicone rubber, capable of remaining flexible at 600 F, has been announced by General Electric Company's silicone products department. Designated class 700, the materials have been designed to extend the application range of silicone rubber to 600 F. The new materials are capable of remaining flexible for 150 hours, or longer, during continuous exposure up to

(*Continued on page 32A*)



revolutionary ALUMINUM CORE BOX† *construction*

withstands HIGH TEMPERATURE • VACUUM IMPREGNATION
HEAVY WINDING STRESSES • SHOCK and VIBRATION

This is a development which calls for immediate changes in purchasing specifications for Tape Wound Cores, because introduction of the Aluminum Core Box means designing your toroids around four important new advantages:

1. Use of an aluminum core box means the new Magnetics, Inc. tape wound cores will withstand temperatures of *at least* 450° F.
2. Because of the unusual seal provided by forming the aluminum over the silicone glass seal, true vacuum impregnation of your coils is now possible. Varnish cannot penetrate the core box and affect magnetic properties of the tape.
3. The strong aluminum construction absolutely prevents deflection of the core box when coils are wound—a distortion-free construction which means no change of magnetic properties.
4. Cushioned with an inert material, the tape winding in the core box is protected against vibration and shock. In most cases it is so completely minimized that it is no longer a problem.

Because of the many advantages of these new Magnetics, Inc. Tape Wound Cores, it will pay you many times over to specify "Aluminum Core Boxes" on your next order.

†PATENT PENDING

Immediately available in 109 standard sizes, using all commercially available magnetic materials.

ALL *Performance-Guaranteed*

For full details, write for
Bulletin TWC-200
Catalog TWC-100

MAGNETICS inc.

DEPT. EN-21, BUTLER, PENNSYLVANIA

(*Continued from page 30A*)

the peak of the new temperature range. Technical information on General Electric class *700* silicone rubber may be obtained by writing the Silicone Products Department, General Electric Company, Waterford, N. Y.

Circuit Breaker Maintenance Simplified. The I-T-E Circuit Breaker Company announces that normal maintenance of 7.2- and 13.8-kv metal-clad switchgear has been made easier by a circuit breaker arrangement which permits each interrupter assembly to be tilted back by hand, and safely anchored in inspection position. With the drawout breaker wheeled out of its compartment, a removable arc-chute support is readily attached at the back and a lifting yoke at the front. Inspection position gives full view of in errupter plates within the chute and makes the entire contact assembly accessible for thorough examination.

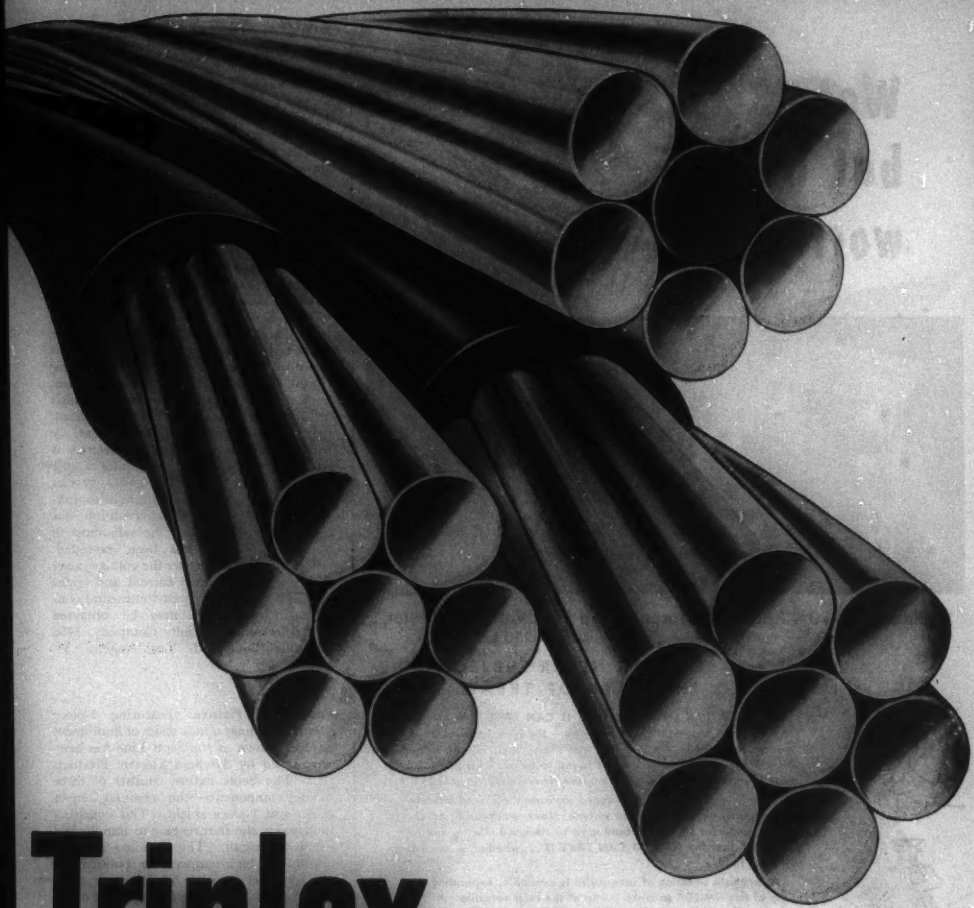
Multiplexer. An RCA-developed universal multiplexer for telecasting both color and black-and-white motion picture films and slides has been announced by the Engineering Products Division, Radio Corporation of America. The new equipment integrates monochrome and color projection facilities, and will enable broadcasters to use a single universal multiplexer, and the same projectors for televising both color and monochrome films and slides. It is scheduled for commercial availability later this year. The multiplexer also will enable broadcasters to preview any one of three other picture sources while a fourth is on the air. The RCA multiplexer, *TP-15*, will enable color broadcasters to consolidate color and monochrome facilities into a single integrated, economical operation. It will enable monochrome broadcasters to consolidate and expand black-and-white film-projection operations, and to convert to color projection without a rearrangement of equipment.

Oil Seal Torque Meter. A hand-operated portable meter that measures rotational torque of oil and grease seals is available from National Motor Bearing Company, Inc. The National oil seal torque meter is a rugged precision device ideal for laboratory measurement or factory inspection. Rotation of the test shaft by a chromium-plated hand crank actuates a calibrated drum to the point where the oil seal's torque is matched exactly by resistance from a coiled spring inside the drum. A pointer then indicates the torque directly in pound-inches on an engraved scale on the calibrated drum. For complete information, write Industrial Sales, National Motor Bearing Company, Inc., Redwood City, Calif.

Miniature Ceramic Rotary Switch. Series *M* ceramic rotary switch, a new miniature unit, is being produced by The Daven Company. This miniature switch has wide

(*Continued on page 36A*)

ELECTRONS, INCORPORATED
127 SUSSEX AVENUE
NEWARK 3, N. J.
Pech + Harvey's Copy Master and Speed Master Whiteprinters use Electrons EL CIK Xenon thyratrons for precise speed control



Triplex

Rome ALUMINUM

Rome Cable Corporation, Rome, New York, and Torrance, California

Wet... but not worried!

Stoddart NM-10A Radio Interference and Field Intensity Meter*
covering the frequency range of 14 kc to 250 kc

CHANCES ARE YOU'LL NEVER SUBJECT YOUR NM-10A TO THIS KIND OF TREATMENT..

BUT IT'S NICE TO KNOW THAT IT CAN TAKE IT IF IT HAS TO! We turned the hose on the AN/URM-6B — the Navy equivalent of the Stoddart NM-10A — in accordance with Navy specifications. Immediately afterward it was disassembled and found to be dry as a bone inside. And much to our satisfaction, the Navy inspector smiled!

Whether you use this fine, rugged instrument for field intensity measurements of carrier current systems, Navy, maritime or other services . . . or for surveys of conducted or radiated interference, you'll find that the ***NM-10A CAN TAKE IT***. . . whether in the lab or in the field.

A complete selection of accessories is available, expanding the utility of the NM-10A to make it one of the most versatile instruments you have ever used.

Write today for further information. Learn about the excellent sensitivity . . . the "hand calibrated" accuracy . . . the sturdy, dripproof construction, enabling use in driving rain or snow . . . the A. C. power supply that permits operation from 105 to 125 volts or 210 to 250 volts A. C., 50 to 1600 cps.

The NM-10A is the identical instrument we supply to the Navy as the AN/URM-6B, a Class One instrument, as shown in MIL-I-16910 (SHIPS). It was designed and is manufactured exclusively by Stoddart Aircraft Radio Co., Inc. When you buy the NM-10A you're getting a quality instrument that meets the rugged requirements of the U. S. Navy!

*** Stoddart RI-FI Meters Cover the Frequency Range of 14 kc to 1000 mc**

NM-20B — HF
15 kc to 25 mc. Commercial equivalent of AN/PRM-1A. Self-contained batteries. A. C. supply optional includes standard broadcast band, radio range, WWW and communications frequencies. Has BFO.

NM-30A — VHF
20 mc to 400 mc. Commercial equivalent of AN/URM-47. Frequency range includes FM and TV bands.

NM-50A — UHF
375 mc to 1000 mc. Commercial equivalent of AN/URM-17. Frequency range includes Citizens band and UHF TV band.

STODDART AIRCRAFT RADIO Co., Inc.
6644 B Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

(*Continued from page 32A*)

use in the manufacture of guided missiles, air-borne equipment, and portable and mobile ground equipment. It occupies a panel area of less than $1^1/_2$ square inches. Inquiries are invited, and Daven's engineering staff is available for consultation on special problems or orders to particular specifications. For information write to The Daven Company, Department SZ, 191 Central Avenue, Newark, N. J.

Aircraft Keyer. Electronic Specialty Company, Los Angeles, Calif., has announced it is now in production on its model *T-198A* Pulsitometer which has been designed to meet United States Air Force requirement for a vibration-resistant keyer to be used in the overheat warning circuit of all aircraft gas turbine engines. Such a keyer is required in aircraft which utilize a single warning light to indicate two different conditions of overheat, or two pickup points. When one detector is wired through the keyer, the pilot is able to differentiate between sources. It can also be used to key a warning light to indicate any other dangerous condition—for example to show when the safe limit of hydraulic pressure has been exceeded. The unit will operate over the voltage range of 14 to 30 volts direct current and under all standard Air Force environmental conditions. Information may be obtained from Electronic Specialty Company, 3456 Glendale Boulevard, Los Angeles 39 Calif.

Fluorescent Fixture. Featuring 1-piece plastic shielding, a new series of fluorescent fixtures known as the Scott Line has been announced by Sylvania Electric Products Inc. The Scott fixture consists of three major components—the channel, cover plate, and 1-piece shield. This construction makes the fixture easy to handle and simple to install. The shielding is made of molded high-temperature polystyrene. The channel is made of 18-gauge cold-rolled steel. A hinging arrangement of the fixture permits the shield to swing down from either side for easy maintenance.

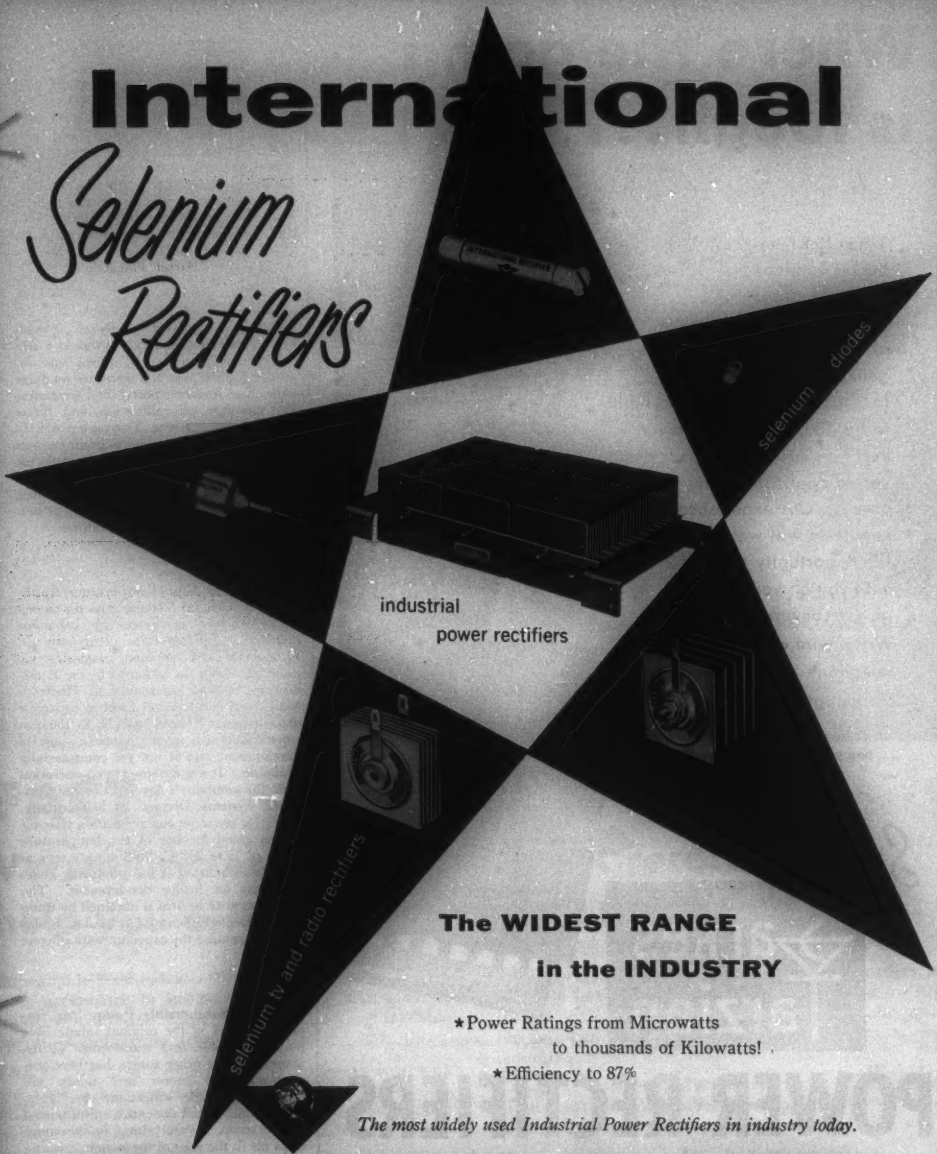
Radiation Shielding. Completely assembled radiation-shielding windows for nuclear research are now available from Corning Glass Works. Consisting of individual castings of radiation-resisting glass up to 10 inches thick stacked together in a framework, the units are shipped ready to install in test cell walls. Used to protect research personnel by reducing radiation intensity to a tolerable level, the windows permit direct observation of work carried out remotely in "hot" areas. Three special glasses with densities of 2.7, 3.3, and 6.2 are used in the windows. These closely match the radiation-absorbing properties of ordinary concrete, barite concrete, and iron or steel. Each of the glasses is sufficiently stabilized to prevent the darkening effect of X-ray and gamma-ray exposure.

Worm Gear Reducer. For long, unsupported vertical output shaft extensions, the

(*Continued on page 38A*)

International

Selenium Rectifiers



The WIDEST RANGE
in the INDUSTRY

★Power Ratings from Microwatts
to thousands of Kilowatts!
★Efficiency to 87%

The most widely used Industrial Power Rectifiers in industry today.

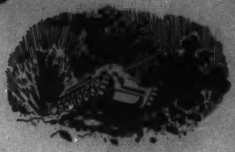
International Rectifier

CORPORATION

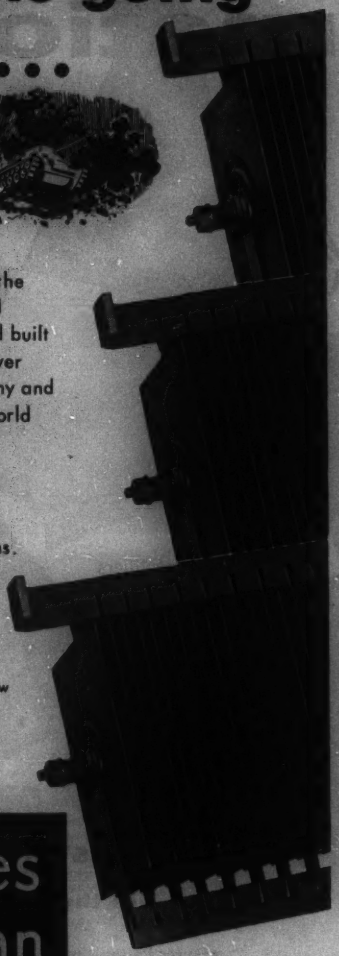
EXECUTIVE OFFICES: 1521 E. GRAND AVE., EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281
New York Office: 501 Madison Avenue, Phone PLaza 3-4942 • Chicago Office: 205 West Wacker Drive, Phone FRanklin 2-3889
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave. W., Toronto, Ontario • Phone RU 1-6174

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

Where the going is tough...



Time after time Sarkes Tarzian Power Rectifiers have demonstrated their ability to "take it" where the going is tough. Engineered for "top" performance and built to last, Sarkes Tarzian Power Rectifiers are found in many and varied applications the world over . . . Our experienced engineers will welcome the opportunity to work with you on your own power conversion problems. Write, wire or telephone Bloomington 2-1435.



See you at the WESCON Show August 24 • 25 • 26

Specify

Sarkes Tarzian

POWER RECTIFIERS

For Dependable Power

WRITE TO: DEPT E-4

Sarkes Tarzian, Inc., Rectifier Division
415 N. COLLEGE AVENUE, BLOOMINGTON, INDIANA

In Canada: 700 Weston Rd., Toronto 9, Tel. Murray 7535 • Export: Ad Auriema, Inc., New York City

(*Continued from page 36A*)

Philadelphia Steeple-type worm gear reducer has been successfully used in a wide variety of applications. The Steeple feature can be mounted on existing standard types of Philadelphia vertical worm gear units without major modifications. The wide bearing span insures extreme rigidity for the extended shaft. An automatic reversing oil pump, together with a filter, is embodied within the unit housing. For additional information, write for catalogue *W-48*, Philadelphia Gear Works, Erie Avenue and G Street, Philadelphia 34, Pa.

Junction Transistor Analyzer. Quantum Electronics Inc., 1921 Virginia Street N. E., Albuquerque, N. Mex., has announced a new junction transistor analyzer with these features: portability, transistorized circuitry, self-calibration, and direct reading measurements. Two parameters, I_{co} and common emitter short-circuit current gain, are measured at a constant collector voltage and adjustable emitter bias. True dynamic small signal current gain is measured at an accuracy of 5 per cent, or better, over wide ambient temperatures.

Capacitor For High-Temperature Applications. General Electric has developed a high-voltage energy-storage capacitor designed to operate in ambient temperatures above 150 C, yet made of nonstrategic materials. Developed jointly by the Transformer Division Laboratory at Pittsfield, Mass., and the General Electric capacitor department at Hudson Falls, N. Y., the new capacitor is still in the advance stage of development and is not yet commercially available. It was designed in co-operation with the company's Aeronautics and Ordnance Systems Division at Schenectady, N. Y., for use in jet engine ignition systems, and is rated for use in the temperature range of 55 to 200 C. Preliminary tests at 260 C indicate that it has promising characteristics for future development. The high resistance to heat is obtained by using silicone-treated mica mat as insulation and by impregnating the capacitor with silicone oil.

Improved Submersible Pump. An improved model of the original submersible pump for cable and transformer vaults, manholes, and other sumps has been announced. The motor and pump are housed in a single watertight case $11\frac{1}{4}$ inches high, so that the entire unit is placed in the sump. Water rising in the sump traps air in the skirt of the switch, creating an air head. When water rises to the predetermined height in the sump, the air head flexes a diaphragm in the switch, closing the switch contacts and starting the motor. If power failure occurs the motor cannot be damaged by water and upon the restoration of power the motor begins to operate immediately. Kenco submersible sump pumps are available in 115 and 230 volts alternating current in three models: *109N* for installations re-

(*Continued on page 40A*)

FACT:

Versatility, economy of Type A recorders help you establish greater system efficiencies

Dependable Westinghouse Type A recorders have gained wide acceptance by utilities for making load surveys. Industry has found them ideal for checking machine operation and factory distribution systems.

FACT: Low Cost—your recording costs are low with the Type A because it is simplified, easy to service . . . maintenance costs are kept to a minimum. The Type A is also low in initial cost . . . you can use it freely whenever, wherever you wish.

FACT: Dependable—high-torque mechanisms give you maximum operating stability under the most severe conditions. Pen friction is decreased, energy consumption is low, precise leveling is unnecessary.

FACT: Versatile—Westinghouse Type A recorders are available in five types to meet your every need for low-cost recording of a-c and d-c voltage and current: portable, switchboard flush, switchboard projection, wall mounting, socket mounting.

You can be sure of accurate recordings or indications of electrical values, whatever the application, when you specify Westinghouse instruments.

• • •

FOR MORE FACTS: Call *The Man With The Facts* . . . your Westinghouse sales engineer. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-40465

YOU CAN BE SURE...IF IT'S

Westinghouse

SINCE 1915 LEADERS IN AUTOMATIC CONTROL

Smoothing Signal Noise with the DBR* Integrator

Confronted with the well-known problem of random fluctuations called "noise," Ford engineers have employed the earliest and best-known Ford component – the disk integrator. Used in Ford analogue computers, the disk integrator smoothes random fluctuations due to extraneous influences and obtains an average of the received signal. Thus, a device originally designed by Ford for integration is successfully used as a mechanical counterpart of the RC Filter.

The Ford circuit operates on the premise that the older the data the less important it is. Therefore, data smoothed must be weighted in proportion to its age, so that the weight assigned to it decreases exponentially with time. The output of the circuit then represents the summation of this weighted data and tends to ignore random noises of short time duration.

As shown in the drawing, the incoming signal (with noise superimposed) is the input to the differential. As long as the integrator output (the roller) rotates at the *same rate* as the incoming signal, the differential output (error signal) is stationary and the integrator carriage remains stationary. But any change in the incoming signal produces changes in the *error signal* which tends to displace the integrator carriage and thus restore the system to equilibrium.

This reaction, however, is not instantaneous. It occurs after a certain time-lag which may be adjusted by the gear ratio. If the signal is of brief, random nature, the time-lag of the integrator will prevent its acting on the system. On the other hand, a permanent change in the signal will displace the carriage and change the output of the system.

This use of the Ford disk integrator as a noise smoother exemplifies the flexibility and adaptability of Ford components and ideas.

*Disk, Balls and Roller Integrator

68

FORD INSTRUMENT COMPANY
DIVISION OF SPERRY RAND CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

ENGINEERS
of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information.

(*Continued from page 38A*)

quiring continuous operation or manual operation; *109A* for completely automatic operation; and *109MA* when manual starting is desired and yet automatic stopping is assured. Literature on Kenco pumps can be obtained by writing Department 505, Kenco, Inc., 1127 North Ridge Road, Lorain, Ohio.

Oscillographs. A new recording oscillograph, engineered to centralize all automatic operating controls on a front panel and designed to simplify internal adjustments, has been developed by Heiland, a division of Minneapolis-Honeywell Regulator Company. The instrument groups such features as record speeds and record length selections, numbering and travel indication, as well as the footage counter and lamp adjustment on a single surface to facilitate operation. One model, *708C*, has a maximum of 36 channels and handles record widths to 8 inches. Another model, *712C*, has a maximum of 60 channels and handles records to 12 inches.

Tester. The Electronics Division of DITMCO Incorporated, Kansas City, Mo., has announced another new product in the automatic tester field. The model *250F* functional tester has 200 test positions with provisions for the operation of a series of external relays in any of the 200 test positions. Complex, interconnected relay systems can be accurately tested for errors in continuity-discontinuity and short circuits, automatically. Frequent design changes in the aircraft and guided missile productions have resulted in the need for test equipment which can readily be changed for various types of tests.

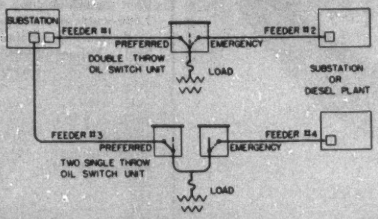
Air-Conditioning Switches. The Arrow-Hart and Hegeman Electric Company, Hartford, Conn., has announced a complete line of 3-position switch controls for air-conditioning units. Featuring maintained contact, these 3-position switches have an OFF position in the center. It is impossible to switch from one circuit to the other without first stopping at the center OFF before moving the switch lever to the second position. Available in 5-ampere 250-volt and 10-ampere 125-volt ratings, the switches are offered in single-pole and double-pole, double throw. Also available is a double-pole double-throw model with 10-ampere 250-volt rating; or 20-ampere 125-volt rating.

Allen-Bradley Resistor. A new, tiny molded resistor measuring 0.140 inch long and 0.015 inch diameter with 1-inch leads and rated at 1/10 watt has been announced by Allen-Bradley Company, 1326 South Second Street, Milwaukee 4, Wis. The type *TR* resistor is a molded composition unit with an insulating coating. It is suitable for use with transistors, diodes, and other small components in miniaturized equipment. It may be used with or with-

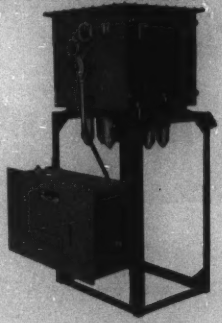
(*Continued on page 42A*)

INSURE SERVICE CONTINUITY

with G&W Automatic transfer oil switches

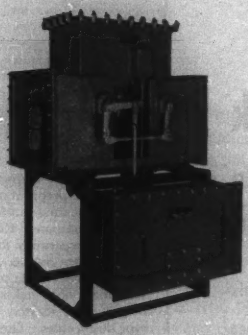


- When preferred feeder voltage fails, the load is automatically transferred to the emergency feeder.
- When preferred feeder voltage is restored (for a period of ¾ minute) the load is automatically returned to the preferred feeder.
- There is no "hunting" on system disturbances. Load cannot be thrown to a "dead" source.
- Model "F6" automatic mechanism provides for remote operator selection of either feeder as the "preferred."

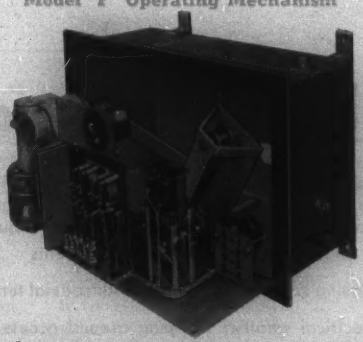


Type "RAD" double throw oil switch unit with Model "F" automatic mechanism.

Model "F" Operating Mechanism



TYPE "DRA" two single throw oil switch unit with Model "F" automatic mechanism. Air filled isolating link box on top.



Improved mechanism removable from watertight case. Motor compresses spring which, when released through action of relays and solenoid, operates the oil switch.

The automatic mechanisms are applied to various forms of Type "RA" oil switches, either for underground cables or overhead connections—up to 23 Kv., 400 amperes. All control wiring is done at the factory. Installation of the unit merely involves connection of the feed and load cables or wires.

Send for Bulletin DA-F which fully describes Model "F" mechanism.

G&W ELECTRIC SPECIALTY CO.

7780 Dante Avenue, Chicago 19, Illinois, U.S.A.

Representatives in principal cities of U.S.A.
In Canada—Powerlite Devices, Ltd., Toronto, Montreal & Vancouver

D-555

1905
50th ANNIVERSARY
1955

(Continued from page 40A)

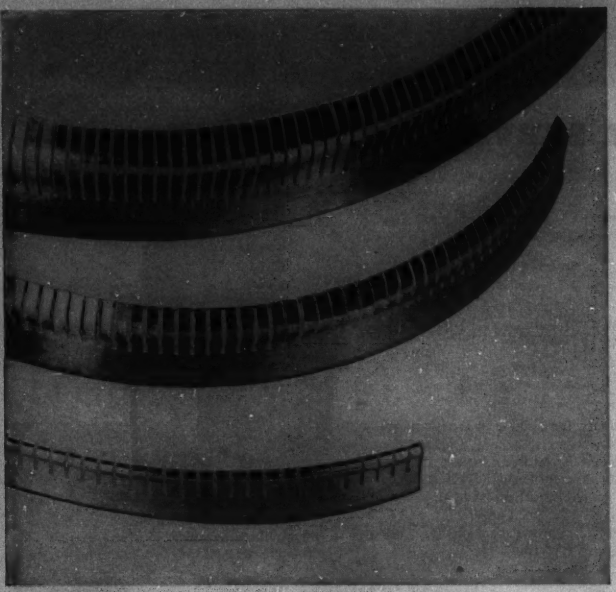
out encapsulating compounds or casting resins.

Line-Loading Voltmeter. Identified as the model *101* line-loading voltmeter, this lightweight portable instrument plugs into a standard 115-volt electric outlet and continuously reads line voltage. A built-in front panel switching arrangement permits 1,000-watt or 2,000-watt line load and reads resulting a-c line volt change due to load. This equipment can quickly determine circuit capacity and adequacy of existing wiring to handle air-conditioning units, freezers, and other appliance installations. For additional details write H. D. Johnson, The Hickok Electrical Instrument Company, 10515 Dupont Avenue, Cleveland 8, Ohio.

Tapes for Vulcanized Splices. A new line of cable splicing tapes for use with standard steam or electric vulcanizers has been developed by The Okonite Company, Passaic, N. J. Known as vulcanizer tapes, the complete line includes rubber insulation, rubber sheath, and colored neoprene sheath tapes that are simple to apply and vulcanize easily into void-free splices equal mechanically and electrically to the cable itself. Developed originally to withstand the rough treatment given portable cables, Okonite vulcanizer tapes may be used wherever the immediate added protection of a vulcanized splice is desired in permanent or fixed cable installations. Write the manufacturer for samples of the tapes, and a copy of bulletin *5505* which gives details and instructions for use.

Xerography. Xerography is now being used in the preparation of spirit and fluid-type duplicating masters. Heretofore, the Haloid Company, Rochester, N. Y., developed xerography for the preparation of offset paper masters, translucent intermediates, and single copies. The latest development now makes xerography capable of preparing masters for spirit and fluid-type duplicators. The new method permits copying with photographic accuracy original documents or existing paperwork without typing, drawing, or tracing onto a master. From original to accurate master, in enlarged or reduced size, the xerographic method requires only about 3 minutes. In the new method the image of the original is transferred, through a XeroX camera and XeroX processor, onto a XeroX plate, and then from the plate to the carbon sheet of the master set. The final step is to run the two sections of the master set, consisting of the carbon and the blank sheet which will become the completed master, through XeroX Flo-Set. In this apparatus, pressure and chemical-vapor action combine automatically to transfer and fuse the printing image from the carbon to the paper. Xerography is capable of making a master from a master while the image on the latter is still good for reproduction. Thus, any need for copies beyond the usual limits of a single master can be simply and quickly

(Continued on page 46A)



Eimac finger stock

...IDEALLY SUITED FOR

- providing good circuit continuity with adjustable or moving contact surface components
- making connections to tubes with coaxial terminals
- electrical weather stripping around access doors to equipment cabinets
- making connections to moving parts such as long line and cavity type circuits

Eimac preformed contact finger stock is a prepared strip of heat treated alloy spring material slotted and formed into a series of fingers. Silver plated for efficient RF conductivity, it comes in widths of 17/32", 31/32" and 1 3/16".

For a complete Eimac Finger Stock data sheet, contact our Technical Services department.

Eimac

EITEL-McCULLOUGH, INC.

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IDENTICAL AMPLIFIERS IN NEW PRECISION CATHODE-RAY OSCILLOGRAPH

THE DU MONT TYPE 340

- Identical, sensitive X- and Y-amplifiers
- Amplifier response dc to 100 kc
- All potentials regulated for stability
- Hard-tube linear sweeps with beam gate
- Mono-accelerator cathode-ray tube for distortionless presentation

Yes, and also precision, simple operation, ruggedness, reliability, ease of maintenance all characterize the *new* Du Mont Type 340 which can well take its place as the oscillograph for those who require the *best* for their important studies.

Identical amplifiers, unexcelled in other commercial instruments, make the Type 340 a powerful tool for measuring electrical phase or mechanical resonance. Controls can be adjusted for less than 1° relative phase shift between amplifiers below 100 kc. Distortion in amplifiers and sweeps is negligible. D-C stability sets new standards. Shifts in level are scarcely observable, even over long periods of operation. The Type 340 truly fits the needs of the discriminating engineer and scientist.

For further information on the Type 340 write to: Technical Sales Department, Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Avenue, Clifton, New Jersey.

In less than a year you have seen a complete new line of *precision* instruments by Du Mont typified by:

Type 336 CRO	dc to more than 20 mc, high brightness
Type 329 CRO	dc to 10 mc, high voltage
Type 327 CRO	dc to 5 mc, precision calibration
Type 324 CRO	microvolt sensitivity, dc to 300 kc
Type 330	universal electronic switch: dc to 15 mc
Type 300	precision time calibrator

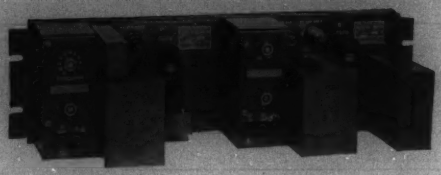
***And now* the Type 340 with identical amplifiers, dc to 100 kc—PRICE $335.00**

TECHNICAL SALES DEPARTMENT
ALLEN B. DU MONT LABORATORIES, INC.,
760 BLOOMFIELD AVE., CLIFTON, N. J.

DU MONT

FREQUENCY-SHIFT V-F CARRIER-TELEGRAPH SYSTEM

Provides one, two, or three frequency-shift teletype channels above the voice on a 3400-cycle telephone circuit



A send and a receive panel require 5¼" of mounting space on a standard 19" rack

This system provides an economical trouble-free method of obtaining up to three full-duplex 100 wpm telegraph channels at the upper end of a broad-band telephone channel, and still retain a 2950-cycle voice circuit. Mid-channel carrier frequencies of 3120, 3240 and 3360 cycles are employed. The mark frequencies are 30 cycles below and the space frequencies are 30 cycles above the mid-band frequencies. The three telegraph channels are transmitted in the band 3080 to 3400 cycles, leaving the band below 2950 cycles for the voice channel.

Fault-free teletype circuits are obtained, even where the telephone circuit on which they are superimposed suffers from noise or abrupt level variations which may be so great as to render on-off keyed signals unintelligible. Frequency-shift signals do not suffer deterioration from non-linear transmission, such as is caused by overloading in voice-frequency, carrier or radio equipment. Under most circumstances a signal-to-noise ratio per channel as low as 20 db is satisfactory, and under some conditions even lower ratios result in fault-free operation. This equipment meets the requirements of current MIL specifications wherever applicable.

RADIO ENGINEERING PRODUCTS

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MANUFACTURERS OF CARRIER-TELEGRAPH, CARRIER-TELEPHONE AND BROAD-BAND RADIO SYSTEMS

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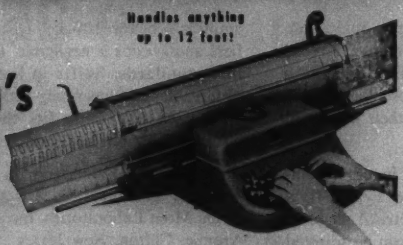

The Vari-Typer lettering machine is the fastest and most economical method of lettering specifications on tracings and drawings. It is four to five times faster than hand lettering and is operated by an office typist. Every letter and figure is uniformly clear and distinct. Instantly changeable type, with hundreds of different styles to choose from in sizes ranging from 6 point to 18 point. Write today for information.

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Body copy produced on DSJ Model. Headlines photo-composed on the Headliner.

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COMPANY.....
ADDRESS.....
CITY .....ZONE...STATE...

(Continued from page 42A)

met through this master-to-master procedure. The advantage will be evident if a new master is required when the original document is not available for recopying. Literature and other information are available from Department SD-1, The Haloid Company, Rochester, N. Y.

Silicone Resins. For those who wish to formulate their own silicone resin-based protective coatings, Dow Corning Corporation offers two different, 100-per-cent silicone resins. Identified as Dow Corning *R-5061* and *R-5071*, both of these resins are available in the form of crumbled solids which are soluble, and compatible with many heat-stable fillers and pigments. Adaptable to formulations requiring uncommon solvents or unusually high solids ratios, both resins are suited to the preparation of silk-screen enamels, or other specialized coatings. Films based on *R-5061* form a tough film with good color retention, while films based on *R-5071* are less flexible and more thermosetting. Intermediate physical properties may be obtained by blending the resins in any desired proportions. Samples and further information are available on request.

TRADE LITERATURE

Lighting Performance Specification-Data Sheets. These data sheets have been prepared by Century Lighting, Inc., and are designed to give essential information for each lighting unit. Use, appearance, performance (light distribution characteristics), size (in terms of a scale drawing) specifications, and price are included in brief nontechnical terms. Engineers can be supplied with additional optical or engineering data on standard units upon request. The folder is designed to hold data sheets on all lighting instruments listed in Century catalogues *1* (theatrical lighting), *2* (architectural lighting), and *3* (television lighting). Requests for data sheets must be in writing on your letterhead. The desired sheets should be identified by stating the catalogue number and title of the unit. In architectural installations describe the use for which the units are intended; the ceiling height in the case of downlights, or general lights; the throw in the case of spotlights or accentlites; and the function of the area, e.g., show window, restaurant, museum, department store, etc. In this way, you can insure getting the data most pertinent to your requirements. Write to: Century Lighting, Inc., 521 West 43d Street, New York 36, N.Y.

Air Reduction Publication List. The Air Reduction Sales Company has announced the availability of a new Publication List. Over 100 welding and cutting technical

(Continued on page 48A)

OVER 500 EXPERIENCED ENGINEERS AND SCIENTISTS* CHOSE DESIGN AND DEVELOPMENT CAREERS WITH RCA DURING THE LAST YEAR!

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	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+
SYSTEMS *(Integration of theory, equipments, and environment to create and optimize major electronic concepts.)*												
AIRBORNE FIRE CONTROL			W						W			
DIGITAL DATA HANDLING DEVICES			C			C			C			
MISSILE AND RADAR			M			M			M			
INERTIAL NAVIGATION			M			M			M			
COMMUNICATIONS			C I						C I			
DESIGN • DEVELOPMENT												
COLOR TV TUBES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photo Sensitive Materials and Glass to Metal Sealing)	L	L	L	L	L	L	L	L	L	L	L	L
RECEIVING TUBES—Circuitry—Life Test and Rating—Tube Testing—Thermionic Emission	H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices	H	H	H				H	H	H			
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave)		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photo Sensitive Devices—Glass to Metal Sealing	L	L	L	L	L	L	L	L	L	L	L	L
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization	C X	C F X	M C F X	C X	C F X	M C F X	C X	C F X	M C F X			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control	C X	M C F X	M C F X	C X	M C F X	M C F X	C X	M C F X	M C F X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming	C	C F X	M C F X	C	C F	M C F X	C	C F	M C F			
COMMUNICATIONS—Microwave—Aviation—Specialized Military Systems	C	C F	M C F		C F	M C F		C F	M C F			
RADIO SYSTEMS—HF-VHF—Microwave—Propagation Analysis—Telephone, Telegraph Terminal Equipment		I	I F		I	I F		I	I F			
MISSILE GUIDANCE—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		M F	M F		M F	M F		M F	M F			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors	C	Z C X	Z C X	C	Z C	Z C	C	C	C		Z	Z
MACHINE DESIGN Mech. and Elec.—Automatic or Semi-Automatic Machines		L	L		L	L		L	L			

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Dept. A-14H Radio Corporation of America
30 Rockefeller Plaza, New York 20, N. Y.

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"My brushes are giving me trouble, doc—how about giving me the Stackpole treatment?"

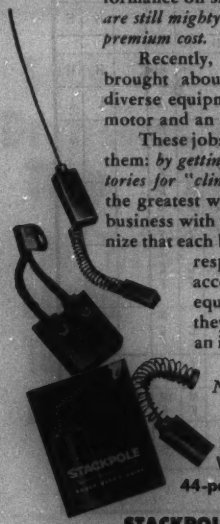
Small Motor Brush Clinic

...for longer life, greater efficiency

No doubt, you're getting pretty good brush life and performance on small motor applications these days. *But, chances are still mighty good that they can be materially improved—at no premium cost.*

Recently, for instance, Stackpole brush developments brought about worthwhile improvement on such widely diverse equipment as toy trains, a coal drill, a d-c gas pump motor and an ac-dc inverter.

These jobs were handled the way Stackpole likes to handle them: *by getting the actual motorized equipment into our laboratories for "clinical" test.* Here, Stackpole engineers combine the greatest wealth of small motor brush "know how" in the business with carefully planned experimentation. They recognize that each brush application differs from others in essential respects. These peculiarities are taken into full account in developing grades exactly suited for the equipment in question. And, more often than not, they come up with a brush recommendation that is an improvement over what has been used in the past.



NOTE: Stackpole brushes are sold only to manufacturers of original equipment.

Write on company stationery for the 44-page Stackpole BRUSH USERS' GUIDE.

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

STACKPOLE

(Continued from page 46A)

reprints, textbooks, safety booklets, slide films, and movies are described in this 16-page booklet. Convenient order cards are included. Request a copy by writing Air Reduction Sales Company, Division of Air Reduction Company, Inc., 60 East 42d Street, New York, N. Y.

Switch Catalogue. A 48-page catalogue containing information for the many types of controllers is available. Engineering and application data plus connection diagrams and dimensions are included. For a copy of catalogue *5509*, write to Furnas Electric Company, 1063 McKee Street, Batavia, Ill.

Booklet on Simplified Drafting. A 36-page booklet on "Simplified Drafting" has been released by the American Machine and Foundry Company (AMF). Authored by J. H. Bergen, Standards Administrator of AMF's Engineering Division, this booklet presents 11 common-sense rules for simplifying drafting practices. Through the medium of sample drawings of engineered parts and assemblies, the 11 rules—from the use of word descriptions for simple parts to making free-hand drawings wherever possible—are illustrated, and a comparison is made between traditional and simplified methods. For additional information write on company letterhead to J. H. Bergen, American Machine and Foundry Company, General Engineering Laboratory, 11 Bruce Place, Greenwich, Conn.

Expanded Stock Instrument Program. Process control instruments are described and illustrated in Fischer and Porter's new 24-page catalogue 2. Included are complete specifications, sizing nomographs, panel mounting diagrams, safe working pressure tables, and basic operating data for the instruments. Catalogue *2* is available on request from Fischer and Porter, 397 Jacksonville Road, Hatboro, Pa.

Treated and Coated Fabric and Paper. A free 20-page catalogue has been published that contains revised and added technical data, descriptions, photographs, applications, and information on treated and coated fabric and paper for electrical insulation users. This catalogue is available from Insulation Manufacturers Corporation. Copies may be obtained by writing the Publications Department, Insulation Manufacturers Corporation, 565 West Washington Boulevard, Chicago 6, Ill.

Liquid Rheostat Bulletin. Design features of Allis-Chalmers liquid rheostat, Type *257*, employing a complete NEMA I enclosure and other improvements are described in a new bulletin released by the company. The type *257* liquid rheostat has been re-engineered for improved performance and low maintenance. It is designed to provide accurate, stepless, wide-range speed control of wound-rotor motor drives. Copies of Allis-Chalmers

(Continued on page 52A)

Locke's Insulator Catalog and Engineering Handbook

Designed to become your favorite source for complete, authoritative purchasing and engineering information on insulators and insulator hardware.

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1. A completely new insulator product section, thumb indexed, makes it easy for you to quickly locate any one of over 800 insulators or insulator hardware items.
2. Complete description of physical characteristics of porcelain.
3. Six pages of clamp recommendations for various conductors.
4. Large section on lightning performance of transmission lines.
5. An expanded section on apparatus bushings with application and maintenance information.
6. Complete listing of all EEI-NEMA Standards, including proposed standards for apparatus insulators. (TDJ-58, 59)
7. The complete American Standards for apparatus bushings and test code.
8. A large general data section including standard insulator tests, cable specifications and many valuable tables for general calculations.

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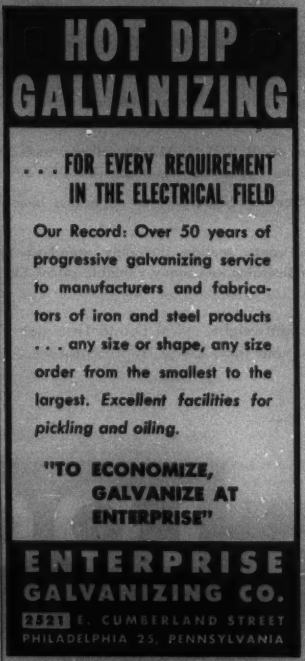
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(*Continued from page 48A*)

type *257* Liquid Rheostat, *14B8231*, are available on request from Allis-Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

Computer Tubes. General Electric Tube Department has published a 50-page booklet on computer tubes for electronic computer designers and manufacturers. This working guide and reference outlines the company's computer tube program, gives complete technical data on the five types in the General Electric line, and includes a review of special computer tube design considerations and application notes. The five tubes described in detail are: *GL-5844*, *GL-5915-A*, *GL-5965*, *GL-6211*, and *GL-6463*. The booklet may be obtained by writing to Tube Department, General Electric, Schenectady, N. Y., for publication *ETD-1140-P*.

Armco Catalogue. Armco Steel Corporations' 24-page illustrated manual covers a wide range of subjects, including magnetic-core uses, mechanical and physical properties, magnetic properties, permeability, annealing practice, machining, welding, and drawing. Copies may be obtained by writing to Product Information Service, Armco Steel Corporation, Middletown, Ohio.

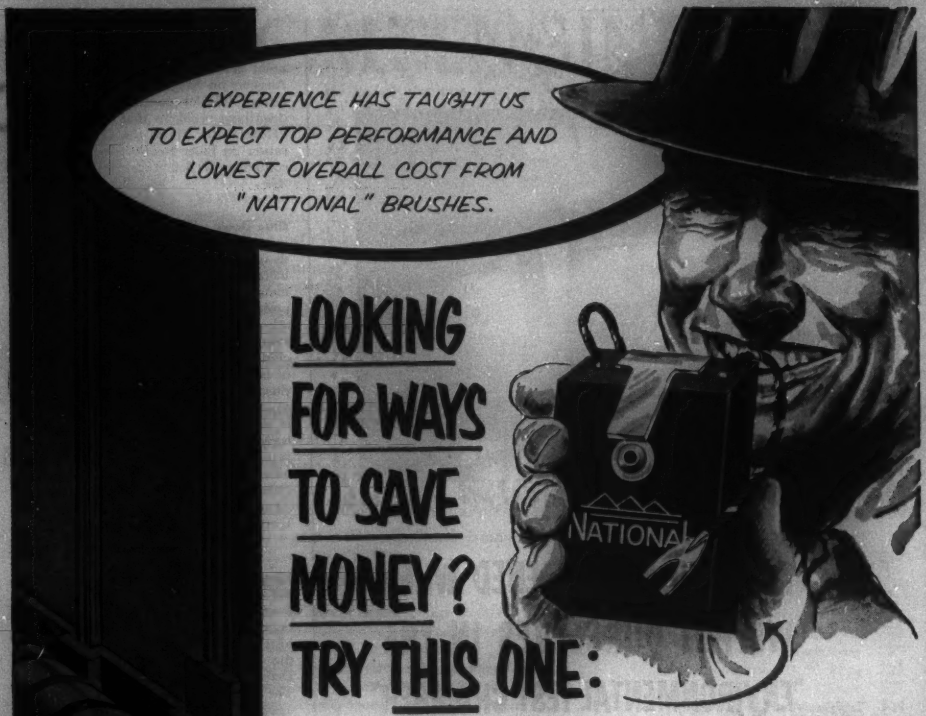
Syntron Catalogue. A condensed catalogue number *554*, containing 50 pages of technical data, brief description and photographs of vibratory equipment, feeders, conveyors, power tools, shaft seals, diesel pile hammers, gasoline hammers, selenium rectifiers, and other materials-handling equipment, has been published by Syntron Company, 440 Lexington Avenue, Homer City, Pa.

New Bulletin. A 1955 price list for *SR-4* strain gauges, instruments, accessories, and cements is announced by Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa. The 12-page booklet includes specifications for all sizes and types of bonded resistance wire strain gauges, and tells how to select the right gauge to meet various conditions of use.

Fixture Catalogue. A complete commercial lighting fixture catalogue for fluorescent and Slimline lights is ready for distribution by Marlou Lights, Inc., Fanwood, N. J. This 28-page catalogue contains all the standard Marlou lighting fixtures, plus many new additions including the Neva-Glare Series and the Marlou "Halo" fixtures. Complete engineering data, specifications, construction details, installation information, and light distribution charts are included.

Three Norelco Pamphlets. Three pieces of literature are available from the Research and Control Instruments Division, North American Philips Company, Inc., 750 South Fulton Avenue, Mount Vernon, N. Y.: "Twenty Questions and Answers on X-ray Analysis"—8-page booklet clearly explaining the difference in X-ray powder camera,

(*Continued on page 58A*)



LOOKING FOR WAYS TO SAVE MONEY? TRY THIS ONE:

If you're not already using "National" brushes on rotating d-c equipment throughout your mine or mill, prove to yourself that this traditionally dependable brush line can effect the following savings for your department:

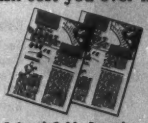
- **Longer Brush Life** — "National" brushes give you the most hours of trouble-free service consistent with other important performance factors. National Carbon research is continually at work on this and other features of "National" brushes.

- **Lower Maintenance** — Often much more important than frequency of brush replacement is commutator condition — a direct result of brush performance. The excellent commutating ability and low friction of "National" brushes contribute to low-cost commutator care.

- **Uniformity** — Brush quality is a link in the chain of dependability upon which uninterrupted service of your equipment depends. National Carbon's inspection procedure is designed to assure you of the same uniformly high quality year after year, from box to box and shipment to shipment.

Brush selection is neither a small nor a simple thing. Install "National" brushes in accordance with recommendations of a National Carbon representative. Then expect and *get* the lowest overall brush cost you ever had!

Are you getting the "Brush Digest"? Many thousands of this free, serialized, motor maintenance course are being distributed to their men by electrical and maintenance supervisors. Write for your copies today!



The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

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Both the Electronics and the Air Arm Divisions of the Westinghouse Electric Corporation are expanding. We need experienced electronic engineers for advanced design and development work . . . so we put ourselves in the "environmental test chamber" to see just what we have to offer the people we need.

We found that we have a professional atmosphere that is ideal for the engineer. We offer advanced study at company expense and merit promotions that assure a good future.

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Baltimore 3, Md.

ILLUSTRATED BROCHURE WILL BE SENT TO ALL APPLICANTS.

(*Continued from page 52A*)

diffractometer, and spectrograph equipment and techniques; "Questions and Answers on Magnetic-Particle Testing"—8-page booklet covering procedure and describing problems that can be handled; "How X-Ray Helps the Celanese Corporation on Fiber Research"—4-page folder containing article reprinted from *Textile Age*.

Blue Book. The H. A. Wilson Company is in the process of distributing nationally its new 192-page "Blue Book" on thermometals (thermostatic bimetals), sintered metals, electrical contact materials, composite and laminated metals, and special alloys. The book is designed to serve as a complete guide for these materials. Included in this book are listings of hundreds of materials, their properties and applications, charts, formulas, and diagrams basic to research and design work in the fields it covers. The firm announced that a copy will be sent free to customers and prospective users of these types of materials who request it on company letterheads, Otherwise, the "Blue Book" sells for $3. The company's mailing address is 2655 United States Route 22, Union, N. J.

Electron Tubes. A 24-page booklet on the Advisory Group on Electron Tubes is now available. It describes the purpose, organization, membership, operation, and history of the organization—an agency of the Office of the Assistant Secretary of Defense for Research and Development. The booklet can be obtained, on request, from the New York University Secretariat, Advisory Group on Electron Tubes, 346 Broadway, New York 13, N. Y. New York University has provided the technical and administrative secretariat for the agency since 1949. Directed by Howard W. Serig, the secretariat is part of the Research Division of the university's College of Engineering. Included in the Advisory Group are receiving tubes, special tubes, power and gas tubes, tube techniques, and semiconductor devices.

Kodagraph Reproduction Materials. All Kodagraph materials available from the Eastman Kodak Company for the preparation and reproduction of drawings and documents are described in a new booklet now being distributed. Of special convenience to the user of these materials is a 2-page materials selection chart designed to help in selecting the Kodagraph film and paper best suited to any job. The original to be reproduced is matched with the equipment to be used in this fully illustrated chart. Kodagraph papers described are the audopositive, repronegative, contact, projection and projection positive, Kodagraph autopositive film, Kodalith films and papers, the Kodagraph data book, and the chemicals developed specifically for use with Kodagraph papers and film are also discussed. Copies of "Kodagraph Reproduction Materials" are available, without charge, from Kodak industrial dealers, or from the Graphic Reproduction Division, Eastman Kodak Company, Rochester 4, N. Y.